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Complete List of Authors:	Sh. Nur, Maryan Abdullahi ; SIMAD University, 1. Department of Obstetrics and gynecology, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Dahie, Hasan Abdullahi ; SIMAD University, 3. Department of Nursing and Midwifery, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Hasan, Nimca Abdi ; Jazeera university, 7. Department of Obstetrics and gynecology, Jazeera university teaching hospital, Faculty of Medicine, Jazira University, Mogadishu, Somalia. Garba, Bashiru ; Usmanu Danfodiyo University, 6. Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, Usmanu Danfodiyo University Sokoto, Nigeria. Adam, Mohamed Husein Adam; SIMAD University, 4. Department of Public Health, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Mohamoud, Jamal Hasan; SIMAD University, 4. Department of Public Health, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Dirie, Najib Isse; SIMAD University, Urology department, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences
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Seroprevalence of SARS-CoV-2 virus antibodies and sociodemographic features of pregnant women in Mogadishu, Somalia

Maryan Abdullahi Sh. Nur[1], Hasan Abdullahi Dahie[3], Nimca Abdi Hasan[7], Bashiru Garba[5,6], Mohamed Husein Adam[4], Jamal Hasan Mohamoud[4], Najib Isse Dirie[2]

1. Department of Obstetrics and gynecology, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
2. Department of Urology, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
3. Department of Nursing and Midwifery, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
4. Department of Public Health, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
5. Institute for Medical Research, SIMAD University, Mogadishu, Somalia.
6. Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, Usmanu Danfodiyo University Sokoto, Nigeria.
7. Department of Obstetrics and gynecology, Jazeera university teaching hospital, Faculty of Medicine, Jazeera University, Mogadishu, Somalia.

***Corresponding author:** Najib Isse **DIRIE**; E-mail: drnajib@simad.edu.so.

ABSTRACT

Objective: Studies have indicated no significant difference between pregnant and non-pregnant women, it is clear that pregnancy tends to increase the chances of having severe outcomes due low immunity of women during pregnancy. However, we do not know the prevalence rate and level of awareness about COVID-19 and the practice of preventive measures against the disease among pregnant women in Somalia. This study aims to determine the prevalence of COVID-19 among pregnant women seeking antenatal care in the Benadir region (Mogadishu) of Somalia and to assess their knowledge and preventive practices towards COVID-19.

Setting: A hospital-based cross-sectional study involving two major referral maternity hospitals in Mogadishu, Somalia.

Participants: Pregnant women seeking antenatal services were included in our study.

Methods: A total of 477 blood samples were collected from pregnant women attending the two referral hospitals in Mogadishu and screened for COVID-19. The participants were subjected to questionnaire interviews where their detailed history and practice of prevention against COVID-19 were evaluated.

Results: The results showed that 175 (36.7%) were positive while 302 (63.3%) samples were negative for SARS-CoV-2 virus antibodies. Also, out of the 141 pregnant women who had two children or less, 19.4% were positive for IgG/IgM antibodies. Participants who had close contact with COVID-19 patients were significantly associated for testing positive with a p-value 0.0001. Students, teachers, employed people, and individuals reported COVID-19 like symptoms were all associated with COVID-19 seropositivity outcomes.

Conclusion: Pregnant women, and those with commorbidies should be given special preventive care and health education about COVID-19 transmission.

Strength and limitation of the study:

- We were able to determine the prevalence of COVID-19 infection among pregnant women in Mogadishu, Somalia with 97.8% specificity.
- The results indicate that multiple birth, and smoking to be potential risk factors for COVID-19 among pregnant women.

- Majority of the pregnant women suffer chronic infection as a result of the predominance of IgG antibodies.
- Despite the 97.1% sensitivity and 97.8% specificity of the test kit, the RT-PCR is still superior in terms of detection of active infection.
- There is also the possibility of cross-reactivity with other corona virus antibodies in circulation.

Keywords: Seroprevalence; COVID-19; Anti-SAR-COV-2 antibodies; Pregnancy; Mogadishu; Somalia.

INTRODUCTION

Since the announcement of the COVID-19 outbreak as a public health emergency of international concern and its subsequent proclamation as a pandemic in the year 2020, the dramatic loss of human life and the associated public health and socio-economic challenges that ensued has been devastating. As of 1 December, 2021, the number of confirmed COVID-19 cases globally stands at 262,178,403, with 5,215,745 deaths [1]. Interestingly, the African continent has the least cases compared to the Americas, Europe, or Asia, despite its seeming poor public health system. Similarly, the case-fatality ratio for COVID-19 in Africa is lower than the global case-fatality ratio, which also implies that the outcome of the SARS-CoV-2 infection has been less severe among African populations [2]. Although, the low number of confirmed cases in the continent is thought to be a result of the low testing rates, which has continued to undermine the continental response [3]. Despite these apprehensions, there is no evidence that a large number of COVID-19 deaths have been missed; instead, the low numbers of confirmed cases can be attributed in part to the lessons learned during the handling of several infectious disease outbreaks that have occurred in the continent including Yellow fever, Ebola, HIV, and AIDS [4].

Despite having one of Africa's most fragile health care systems, occasioned by the ongoing conflict and destruction of public health infrastructure, the number of cases in Somalia is relatively low. However, cases have in recent months increased tenfold, and there are indications of community transmission beyond the major cities [5]. The risk of acquiring COVID-19 is

known to be higher among the elderly as well as individuals with underlying comorbidities, including moderate to severe asthma, diabetes, cardiovascular diseases, and other respiratory illnesses, including pregnancy which predisposes to severe illness [6,7]. The pandemic has disproportionately impacted vulnerable groups such as persons with disabilities and internally displaced people living in makeshift camps in Somalia. The above has been driven by the non-adherence to the outlined public health measures and has contributed significantly to the increasing number of cases recorded in the country.

Although pregnant women do not seem to be at a higher risk of getting COVID-19. In other words, being pregnant does not increase the chances of getting COVID-19 more than non-pregnant persons; however, studies have shown the likelihood of developing severe COVID-19 symptoms if infected [8]. There are also emerging evidence that the risk of having stillbirth may be higher among pregnant COVID-19 patients [9]. These pre-neonatal and neonatal period complications are attributed to pregnant women's reduced respiratory capacity, low immunity, and the hemodynamic changes they undergo. The risk of severe maternal outcomes is even higher if they have pulmonary comorbidities, hypertensive disorders, and diabetes mellitus [10]. Moreover, investigations have shown women to be a vulnerable group during the COVID-19 pandemic. This worry is even more among pregnant women who occasionally experience pregnancy and postpartum mental illnesses (depression, anxiety, and postpartum psychosis), resulting in bipolar disorder [11]. These situations are a cause for concern in Somalia, whose women of reproductive age represent 38% of the household, with a worrying maternal mortality rate of 692 [12]. Also, among the 23,102 cases as of 2/12/2021, 26% (amounting >6006 cases) are female.

The main strategy for each country is to vaccine their general public against COVID-19; the WHO and all governments around the globe are doing their best efforts and advocacy for mass vaccination. To date, a total of 7,772,799,316 vaccine doses have been done according to the data released daily by the WHO. The Ministry of health (MoH) of the federal government of Somalia has been vaccinating the public since 2020 based on vaccines donated by international organizations and some governments. Since the vaccination program started, the MoH was hesitant to vaccinate pregnant women for lack of evidence; however, on 18 November 2021, they

released a newsletter stating that MoH recommends vaccinating pregnant women with a single dose J&J COVID-19 vaccine after the first trimester.

This survey was conducted among pregnant women to study if they were exposed to COVID-19 based on the OnSite COVID-19 IgG/IgM Rapid Test that detects anti-SARS-CoV-2 IgG and IgM antibodies in serum and plasma. Also, a questionnaire was administered to consenting participants to determine demographic characteristics and potential risk factors for COVID-19. The aim was to estimate the prevalence of diagnosed COVID-19 among pregnant women in Somalia's Benadir region.

MATERIAL AND METHODS

Study Design: We present a cross-sectional study aiming to estimate the Seroprevalence of SARS-CoV-2 antibodies among pregnant women attending referral hospitals in Mogadishu, Somalia, from July 31st 2021 to August 31st 2021 (**Figure 1**). Women who indicated their informed consent and had no history of COVID-19 vaccination were included in the survey. Participants who did not consent to participate in the study were excluded.

Study Setting: The selected hospitals are the major two referral hospitals for mother and child in the capital city of Mogadishu. Both hospitals are located on either side of the city and routinely offer free medical services to the mother and child. One hospital in the south provides services to the most vulnerable in the society, mainly the internally displaced people (IDP) from the regions in the south of Somalia. And the other hospital located in the north of the city covers the city's north districts, including patients from nearby central Somalia regions. The consenting participants were administered a questionnaire covering demographics, obstetrical history, general health status, COVID-19 status, and COVID-19 preventive measures. The questionnaire was prepared using Google form for ease of use, processing, and analyzing the data generated.

Sample size determination

We assumed a 50% prevalence since no study had previously been done to determine the Seroprevalence of COVID-19 antibodies among pregnant women in Somalia.

Therefore, based on the Cochran's formula for sample size calculation ($N = Z^2 \times P\ (1\text{-}P) \div \varepsilon^2$)

Where, Z is 1.96 (constant), e is the desired level of precision (i.e. 5% margin of error at 95% confidence interval), p estimated prevalence (5.7%), and q is 1 – p.

Therefore

$N = Z^2 \times P (1-P) \div \varepsilon^2$

$N = 3.8416 \times 0.5 (1-0.5) \div 0.0025$

N = 384.16 samples

However, in order to increase our chances of detection, 477 samples were collected.

Serological Testing: Participants were tested with the CTK BIOTECH's OnSite COVID-19 IgG/IgM Rapid Test (California, USA) following the instructions given by the manufacturer. Four trained doctors, assisted by three junior doctors, and a final year obstetrician-gynecology postgraduate student participated in the blood sample collection and filling of the Google form questionnaires according to inputs from the participants (pregnant women attending antenatal services). Participants were given a detailed explanation of the study purpose and procedure, while the confidentiality of their data was granted.

The study's primary outcome was the seroprevalence of IgG & IgM-specific antibodies in a cohort of pregnant women during the study period. In our analysis, we stratified the population according to the results of the serological study (IgG, IgM, & IgG/IgM positive vs. negative group). Those with positive IgG/IgM were further subdivided depending on the presence or absence of COVID-19 related risky behaviors, obstetrical characteristics, history of chronic illnesses, and COVID-19 symptoms at any time before the serological study using descriptive and inferential analysis.

Statistical Analysis: For the descriptive analysis, the general distribution of all the variables included in this study was assessed by frequency and percentages for categorical variables and means and standard deviations for continuous data using SPPS statistical software version 25. For inferential analysis, we used logistic regression to examine the relationship between predictor variables and the outcome variables.

Patient and Public Involvement: It was not appropriate or possible to involve patients or the public in the design, or conduct, or reporting, or dissemination plans of our research.

Research Ethics Approval: The investigation commenced after Our Institutional Review Board approved all study procedures (SIMAD University Ethics Committee. **ID:** IMRSU/FMHS (FR18) P003).

RESULTS

From July 31st 2021 to August 31st 2021, a total of 477 eligible pregnant women were tested for SARS-COV-2 specific antibodies. The single-use lateral flow immunoassay test kit is used for detection and differentiation of anti-SARS-CoV-2 IgG and IgM immunoglobulins where a total of 302 (63.3%) serum samples were found to be negative for SARS-CoV-2 while 175 (36.7%) turned out to be positive (**Figure 2a**). Similarly, 34% of the circulating antibodies were IgG indicating long-term infection, while IgM circulation was found in only 2% of the women (**Figure 2b**).

The COVID-19-related sociodemographic characteristics analyzed, including age, education level, and the number of people in the household, were all found not to be statistically significant ($p>0.05$). However, other demographics studied like marital status, divorced women who were pregnant were more likely (22%) to contract COVID-19 (**Table 1**). Similarly, in terms of the level of education, being a student, a teacher, or employed were found to be statistically significant risk factors for contracting COVID-19 with p-values of 0.009, 0.027, 0.003, respectively.

Table 1: Socio-demographic characteristics of pregnant women in Mogadishu, Somalia

Demographics	N	COVID-19 (IgG/IgM)		OR at 95%CI	P value
		Positive (175)	Negative (302)		
Age					
15-19 years	92	31 (17.7)	61 (20.2)	1.259(0.765-2.0271)	0.365
20-24 years	121	41 (23.4)	80 (26.5)	1.248(0.796-1.959)	0.335
>24 years	264	103 (58.9)	161 (53.3)	Ref.cat	
Marital status					
Married	341 (71.5)	109 (62.3)	232 (76.8)	Ref.cat	
Divorced	106 (22.2)	56 (22.0)	50 (16.6)	0.419(0.269-0.654)	0.0001*
Widowed	30 (6.3)	10 (5.7)	20 (6.6)	0.940(0.425-2.076)	0.878
Educational level					
Informal	267	83 (47.4)	184 (60.9)	1.260(0.723-2.194)	0.415
Primary	39	16 (9.1)	23 (7.6)	0.817(0.365-1.827)	0.622
High school	102	51 (29.1)	51 (16.9)	0.568(0.304-1.062)	0.077
University	69	25 (14.3)	44 (14.6)	Ref.cat	
Occupation					
Student	74 (15.5)	34 (19.4)	40 (13.2)	0.500(0.296-0.843)	0.009*
Teacher	11 (2.3)	7 (4.0)	4 (1.3)	0.243(0.069-0.851)	0.027*
Employed	107 (22.4)	49 (28.0)	58 (19.2)	0.503(0.318-0.795)	0.003*
Unemployed	285 (59.7)	85 (48.6)	200 (66.2)	Ref.cat	
No. of household					
1-5	103 (21.6)	32 (18.3)	71 (23.5)	Ref.cat	
6-10	213 (44.7)	82 (46.9)	131 (43.4)	0.720(0.437-1.188)	0.198
>10	161 (33.8)	61 (34.9)	100 (33.1)	0.739(0.437-1.249)	0.258

* Statistically significant at the 0.05 level

According to the obstetrical characteristics of the respondents, 34 (19.4%) of women who reported they had given birth to less than two children were found to have circulating levels of SARS-CoV-2 antibodies, and this result was statistically significant at p=0.0001. While the other variables (history of abortion and stage of gestation) were not a potential risk factor to acquiring COVID-19 since none of them was found to be significant (**Table 2**).

Table 2: Obstetric characteristics of pregnant women in Mogadishu, Somalia

Characteristic	N	COVID-19 IgG/IgM test		OR 95%CI	P value
		Positive (175)	Negative (302)		
Parity					
0-2	141 (29.6)	34 (19.4)	107 (35.4)	0.439(0.289-0.684)	0.0001*
>2	336 (70.4)	141 (80.6)	195 (64.6)	Ref.cat	
History of abortion					
Yes	105 (22.0)	35 (20.0)	70 (23.2)	0.829(0.525-1.308)	0.420
No	372 (78.0)	56 (22.0)	50 (16.6)	Ref.cat	
Gestational age					
<13 weeks	65 (13.6)	29 (16.6)	36 (11.9)	Ref.cat	0.127
14-26 weeks	92(19.3)	30(17.1)	62 (20.5)	1.665(0.865-3.205)	0.206

* Statistically significant at the 0.05 level

Some of the unhealthy behaviors reported to increase the risk of other respiratory illnesses were also evaluated in this study. Notable among them is the smoking of cigarettes, Shisha, and the local habit of chewing Khat (*Catha edulis*), a stimulant plant frequently chewed among Somalis. Among these, only the smoking of shisha (4.6% positive) was found to pose a risk for contracting COVID-19 infection due to sharing of pipes.

Furthermore, human-to-human transmission of COVID-19 is precipitated by close contact with family members and is usually high when the number of families in a household is considerable. In order to evaluate the association between the number of people in the household with the risk of contracting the infection, participants were asked questions relating to knowledge about their COVID-19 status, familiarity with the basic clinical signs of COVID-19, the possibility of transmission within family members as well as observance of public health preventive measures (**Table 3**).

Table 3: COVID-19 status among pregnant women in Mogadishu, Somalia

Characteristic	N	COVID-19 (IgG/IgM)		OR 95%(CI)	P value
		Positive (175)	Negative (302)		
Were you ever tested for COVID-19?					
Yes	139 (29.1)	67 (38.3)	72 (23.8)	1.982(1.324-2.967)	0.001*
No	338 (70.9)	108 (61.7)	230 (76.2)	Ref.cat	
What was the result?					
Positive	55 (11.6)	34 (19.5)	21 (7.0)	0.283(0.156-0.511)	0.0001*
Negative	96 (20.2)	38 (21.8)	58 (19.2)	0.698(0.436-1.119)	0.135
Not applicable	325 (68.3)	102 (58.6)	223 (73.8)	Ref.cat	
Have you ever had COVID-19?					
Yes	102 (21.4)	60 (34.3)	42 (13.9)	0.639(0.385-1.060)	0.083
No	222 (46.5)	42 (24.0)	180 (59.6)	3.911(2.464-6.207)	0.0001*
Not sure	153 (32.1)	73 (41.7)	80 (26.5)	Ref.cat	
Did you have COVID-19 symptoms?					
Yes	193 (40.5)	126 (72.0)	67 (22.2)	9.019(5.883-13.827)	0.0001*
No	284 (59.5)	49 (28.0)	235 (77.8)	Ref.cat	
Did you have fever?					
Yes	212 (44.4)	130 (74.3)	82 (27.2)	7.751(5.076-11.836)	0.0001*
No	265 (55.6)	45 (25.7)	220 (72.8)	Ref.cat	
Did you have cough?					
Yes	216 (45.3)	138 (78.9)	78 (25.8)	10.711(6.864-16.715)	0.0001*
No	261(54.7)	37 (21.1)	224 (74.2)	Ref.cat	
Did you lose your smell?					
Yes	180 (37.7)	127 (72.6)	53 (17.5)	12.430(7.964-19.401)	0.0001*
No	297 (62.3)	48 (27.4)	249 (82.5)	Ref.cat	
Did you lose your taste?					
Yes	166 (34.8)	118 (67.4)	48 (15.9)	10.955(7.043-17.038)	0.0001*
No	311 (65.2)	57 (32.6)	254 (84.1)	Ref.cat	
Did you have stomach upset?					
Yes	135 (28.3)	103 (58.9)	32 (10.6)	12.070(7.512-19.395)	0.0001*
No	342 (71.7)	72 (41.1)	270 (89.4)	Ref.cat	
Did you have shortness of breath?					
Yes	170 (35.6)	122 (69.7)	48 (15.9)	12.181(7.796-19.031)	0.0001*
No	307 (64.4)	53 (30.3)	254 (84.1)	Ref.cat	
When was the time you had the symptoms					
<3 months	87 (18.2)	48 (27.4)	39 (12.9)	0.075(0.039-0.0146)	0.0001*
3-6 months	35 (7.3)	22 (12.6)	13 (4.3)	0.055(0.023-0.129)	0.0001*
>6 months	166 (34.8)	89 (50.9)	77 (25.5)	0.080(0.044-0.145)	0.0001*
Not applicable	189 (39.6)	16 (9.1)	173 (57.3)	Ref.cat	
Close contact with someone having COVID-19					
Yes	158 (33.1)	110 (62.9)	48 (15.9)	0.218(0.117-0.407)	0.0001*
No	256 (53.7)	44 (25.1)	212 (70.2)	2.409(1.201-4.462)	0.005*
Not sure	63 (13.2)	21 (12.0)	42 (13.9)	Ref.cat	
Did any household contact colleagues or close friend had COVID-19?					
Yes	195 (40.9)	126 (72.0)	69 (22.8)	8.683(5.674-13.288)	0.0001*
No	282 (59.1)	49 (28.0)	233 (77.2)	Ref.cat	
Was anyone of your close contacts hospitalized for COVID-19					
Yes	169 (35.4)	115 (65.7)	54 (17.9)	8.802(5.732-13.518)	0.0001*
No	308 (64.6)	60 (34.3)	248 (82.1)	Ref.cat	
Did anyone of your close contacts die of COVID-19?					
Yes	182 (38.2)	124 (70.9)	58 (19.2)	10.229(6.628-15.785)	0.0001*
No	295 (61.8)	51 (29.1)	244 (80.8)	Ref.cat	

* Statistically significant at the 0.05 level

A total of 193 pregnant women reported having had COVID-19 infection, out of which 126 (72%) presented clinical signs indicative of the disease while asymptomatic were 67(22.2%). The most common symptom presented by the infected women were cough (78.9%), fever (74.3%), shortness of breath (69.7%), loss of smell (72.6%), and stomach upset (58.9%). The timing of symptoms appearing differed significantly between gestations, first trimester (27.4%), second trimester (12.6%), and third trimester (50.9%). Close contact with a family member of someone who had COVID-19 was also a significant finding for testing positive with a p-value =0.004. We also observed that the number of close contacts the respondents knew who had A total of 193 pregnant women reported having had COVID-19 infection out of which 126 (72%) presented clinical signs indicative of the disease while asymptomatic were 67(22.2%). The most common symptom presented by the infected women were cough (78.9%), fever (74.3%), shortness of breath (69.7%), loss of smell (72.6%), and stomach upset (58.9%). The timing of symptoms appearing differed significantly between gestations, first trimester (27.4%), second trimester (12.6%), and third trimester (50.9%). Close contact with a family member of someone who had COVID-19 was also a significant finding for testing positive with a p-value =0.004. We also observed that the number of close contacts the respondents knew whom COVID-19 had was more likely hospitalized (65.7%) or died of the infection (70.9%).

Observing social and physical distances was statistically significant compared with not observing this essential preventive measure (**Table 4**). The result revealed that 41.7% of the respondents admitted to observing distancing among others (168), which is lower than the number of respondents that admitted to not practicing distancing (308), and this was found to be statistically significant ($p<0.05$). Except for the use of face mask, which showed the number of those using it (268) was higher than those not using (209), the adherence to other preventive measures was poor, particularly frequent hand washing, which showed 93% not practicing handwashing compared to 82% that claimed they regularly wash their hands. Importantly, this finding was not statistically significant; however, the odds are greater than 1, implying that not adhering to these preventive measures could increase the chances of contracting COVID-19.

Table 4: Preventive measures observed by the of pregnant women in Mogadishu, Somalia

Characteristic	N	COVID-19 (IgG/IgM)		OR 95%CI	P value
		Positive (175)	Negative (302)		
Do you regularly wear face mask?					
Yes	268 (56.2)	108 (61.7)	160 (53.0)	1.431(0.979-2.091)	0.064
No	209 (43.8)	67 (38.3)	142 (47.0)	Ref.cat	
If "yes", what types of mask do you wear?					
N95	43 (9.0)	18 (10.3)	25 (8.3)	Ref.cat	
Surgical face mask	79 (16.6)	23 (13.1)	56 (18.5)	1.753(0.807-3.810)	0.156
Others	163 (34.2)	70 (40.0)	93 (30.8)	0.957(0.484-1.889)	0.898
Not applicable	192 (40.3)	64 (36.6)	128 (42.4)	1.440(0.732-2.831)	0.290
Do you regularly wash your hands					
Yes	205 (43.0)	82 (46.9)	123 (40.7)	1.283(0.882-1.868)	0.193
No	272 (57.0)	93 (53.1)	179 (59.3)	Ref.cat	
Do you keep your distance from others					
Yes	168 (35.2)	73 (41.7)	95 (31.5)	1.559(1.060-2.295)	0.024*
No	309 (64.8)	102 (58.3)	207 (68.5)	Ref.cat	
Do you avoid handshaking?					
Yes	164 (34.4)	66 (37.7)	98 (32.5)	1.260(0.854-1.860)	0.244
No	313 (65.6)	109 (62.3)	204 (67.5)	Ref.cat	

* Statistically significant at the 0.05 level

Comorbidities of pregnant women with confirmed SARS-CoV-2 infection are shown in **Table 5**. There was a significant difference in mean between the COVID-19-positive pregnant women and COVID-19 negative pregnant women across all the comorbidities inquired (diabetes, hypertension, cardiovascular disease, and asthma) with a p-value of 0.001. The odds ratio was also greater than 1, which means greater odds of association with having any chronic illness and the chances of becoming infected with COVID-19.

Table 5: Comorbidities of pregnant women with conformed SARS-CoV-2 infection

Characteristic	N	COVID-19 (IgG/IgM)		OR 95%CI	P value
		Positive (175)	Negative (302)		
Do you have diabetes?					
Yes	94(19.7)	50 (28.6)	44 (14.6)	2.345(1.484-3.708)	0.0001*
No	383 (80.3)	125(71.4)	258 (85.4)	Ref.cat	
Do you have hypertension?					
Yes	124 (26.0)	67 (38.3)	57(18.9)	2.667(1.753-4.056)	0.0001*
No	353 (74.0)	108 (61.7)	245 (81.1)	Ref.cat	
Do you have cardiac disease?					
Yes	85 (17.8)	46 (26.3)	39 (12.9)	2.811(1.721-4.590)	0.0001*
No	392 (82.2)	129 (73.7)	263 (87.1)	Ref.cat	
Do you have asthma?					
Yes	85 (17.8)	46 (26.3)	39 (12.9)	2.405(1.494-3.870)	0.0001*
No	392 (82.2)	129 (73.7)	263 (87.1)	Ref.cat	
Do you have family history of hypertension?					
Yes	137 (28.7)	63 (36.0)	74 (24.5)	1.733(1.156-2.598)	0.008*
No	340 (71.3)	112 (64.0)	228 (75.5)	Ref.cat	
Do you have family history of diabetes?					
Yes	148 (31.0)	72 (41.1)	76 (25.2)	2.079(1.397-3.094)	0.0001*
No	329 (69.0)	103 (58.9)	226 (74.8)	Ref.cat	
Do you have family history of cardiac disease?					
Yes	155 (32.5)	76 (43.4)	79 (26.2)	2.167(1.461-3.213)	0.0001*
No	322 (67.5)	99 (56.6)	223 (73.8)	Ref.cat	
Do you have family history of asthma?					
Yes	137 (28.7)	64 (36.6)	73 (24.2)	1.809(1.206-2.712)	0.004*
No	340 (71.3)	111 (63.4)	229 (75.8)	Ref.cat	
Do you have family history of obesity?					
Yes	193 (40.5)	89 (50.9)	104 (34.4)	1.970(1.348-2.880)	0.0001*
No	284 (59.5)	86 (49.1)	198 (65.6)	Ref.cat	
Do you take regular medications?					
Yes	137 (28.7)	66 (37.7)	71 (23.5)	0.494(0.328-0.744)	0.001*
Herbal medication	19 (4.0)	8 (4.6)	11 (3.6)	0.631(0.246-1.617)	0.338
No	321 (67.3)	101 (57.7)	220 (72.8)	Ref.cat	

* Statistically significant at <0.05

DISCUSSION

This study investigated the prevalence, knowledge, and preventive practices towards COVID-19 among pregnant women seeking antenatal services in two of the major public hospitals in Mogadishu, within the Benadir region of Somalia. This study coincided with the third wave of the COVID-19 outbreak in Somalia around early July 2021. During this period, a total of 477 pregnant women were screened for confirmation of COVID-19 using the CTK BIOTECH's OnSite COVID-19 IgG/IgM Rapid Test kit which is capable of identifying SARS-CoV-2 antibodies with 97.1% and 97.8% sensitivity and specificity respectively [15]. To date, the most reliable method of detecting SARS-CoV-2 infection is RT-PCR [13,14]. Nonetheless, the OnSite COVID-19 IgG/IgM Rapid Test can identify individuals with circulating antibodies against the SARS-CoV-2 virus either as a result of recent or prior infection [15]. In this study, the predominant immunoglobulin among the COVID-19 positive pregnant women was IgG with 34% circulation followed by IgM with 2%. During the acute phase of COVID-19 infection, IgM blood levels against SARS-CoV-2 rise rapidly and peak after 2-3 weeks of contracting the virus, followed by SARS-CoV-2 specific IgG antibodies appear and persist in the circulation for months. The majority of the COVID-19 positive pregnant women sampled had a chronic long-term infection. This outcome is similar to the previous report where titers of IgG targeting N-protein of SARS-CoV2 was recommended as a prognostic factor in understanding the clinical course of COVID-19 and that it should be measured in all patients with SARS-CoV2 infection [16].

The overall prevalence of SARS-CoV-2 infection among pregnant women was 36.7%, with 3% of the total having an active infection, but none needed critical care. Even though earlier studies have reported a prevalence of 61% among healthcare workers, the 36.7% recorded in this study is distressing, this is because the 61% we referred to was from a study conducted among healthcare workers in Somalia [17]. It is not a surprise to see a high number of cases among this category of people because they constitute the frontline workers at the most significant risk of contracting the disease.[18] This figure (36.7%) is considerably high when studies were done in Japan and New York, which found a seroprevalence of 0.03% and 16.4%, respectively [10,19].

Concerning the adherence to the outlined preventive measures, including avoiding crowd, frequent washing of hands with detergents or disinfectants, and the use of face coverings, we observed a worrying trend where the majority of the respondents admitted to not practicing these aforementioned public health guidelines with an increased odd of contracting the disease as a result (OR>1). This undesirable habit of not adhering to the recommended preventive practice may give further credence to the high number of positive cases recorded in this study. We understand that observing these set-out regulations will be challenging and complex because of some Somali culture and traditions of congregating, sharing hugs, and shaking hands. Nonetheless, considering the vulnerabilities of pregnant women, there is an urgent need to ensure compliance with these COVID-19 requirements; otherwise, things may only worsen for pregnant women in Somalia.

Additional vital findings in this study are the relationship of COVID-19 positive status and comorbidity. Since the first outbreak, we have come to realize that SARS-CoV-2 infects people of all age groups; however, elderly people (above 60 years), as well as individuals with comorbidities such as chronic respiratory disease (asthma patients), diabetes and cardiovascular diseases, are at a greater risk of developing infection with severe outcomes [20,21]. Although most of the respondents admitted to not having any of the chronic disease conditions asked, viz hypertension, diabetes, asthma, cardiovascular disease, and obesity (74-82%). Nevertheless, many pregnant women (17.8-28.7%) indicated they have one or more of these comorbidities, as mentioned earlier, which will increase the risk for them and their unborn children.

Other potential risk factors evaluated in this study, such as parity, history of abortion, stage of gestation, and some unhealthy behaviors like smoking, revealed no significant relationship concerning increasing chances of contracting COVID-19 among pregnant women, with an odds ratio of 0.4 to 0.8. However, the risk for contracting the disease for smokers of Shisha was very high with an odds ratio of 3.569, and this finding was statistically significant (p=0.04). Like other studies, none of the different trimesters of pregnancy was associated with a high risk of getting the infection. A study done in Spain found that Seroprevalence was similar between women in the first trimester of pregnancy and women in the third trimester, suggesting a similar risk of infection. However, the proportion of women with symptoms and those requiring

hospitalization was higher in the third-trimester group than in the first-trimester group [22,23]. On the other hand, available data have already indicated that smoking doubles the risk of having severe COVID-19 [24]. Lung damage from COVID-19 resembles the damage of smoke from cigarettes and other tobacco products that introduce particulate matter from the environment into the lungs. Notably, the mouthpiece and the hose in the shisha can serve as a means of transmission of the COVID-19 virus, which can also spread through shisha sharing.

Participants who reported COVID-like symptoms were more likely to turn positive when tested for COVID-19. Though some reported no history of COVID-19 infection, this wave arrived simultaneously with the already expected seasonal flue. The order and frequency of symptoms were almost the same with a study done in Mogadishu in which the most typical symptom reported was cough (>75%), followed by fever (>71%) and loss of taste and smell [25]. Other studies show that fever and cough were the most typical symptoms reported, followed by stomach upset [26]. We also observed that pregnant women who reported having had a previous infection with COVID-19 were more likely to test positive. Though COVID-19 specific immunity may disappear in three months, one may believe that since they were infected in previous waves, they still sustain immunity and do not practice preventive measures [27].

In conclusion, the COVID-19 high prevalence observed in this study is disturbing considering how vulnerable pregnant women can be, especially in Somalia, where the healthcare services face serious challenges. The poor attitude in observing preventive measures against COVID-19 among pregnant women also warrants serious attention towards raising awareness among midwives and health care workers who are in close contact with women delivering babies to reduce infection transmission and ensure prevention and control of the virus.

Author Contribution: Najib Isse Dirie, and Maryan Abdullahi Sh. Nur conceived the study and drafted the original protocol. Najib Isse Dirie, Hasan Abdullahi Dahie, Nimca Abdi Hasan, Mohamed Husein Adam, and Bashiru Garba, contributed to developing the survey questionnaires. Hasan Abdullahi Dahie, Jamal Hasan Mohamoud, and Bashiru Garba played a major role in the statistical analyses. All the authors participated in, read and approved the final manuscript.

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References

1. Somalia: WHO Coronavirus Disease (COVID-19) Dashboard With Vaccination Data | WHO Coronavirus (COVID-19) Dashboard With Vaccination Data [Internet]. [cited 2021 May 25]. Available from: https://covid19.who.int/region/emro/country/so
2. Partnership for Evidence-Based Response to COVID-19 (PERC) - Prevent Epidemics [Internet]. [cited 2021 Nov 13]. Available from: https://preventepidemics.org/covid19/perc/
3. Chitungo I, Dzobo M, Hlongwa M, et al. COVID-19: Unpacking the low number of cases in Africa. *Public Heal Pract* 2020;13:1:100038.
4. Nkengasong J. Let Africa into the market for COVID-19 diagnostics. *Nature* 2020; 30:565–565.
5. COVID-19 in Somalia: A Public Health Emergency in an Electoral Minefield | Crisis

Group [Internet]. [cited 2021 Nov 13]. Available from: https://www.crisisgroup.org/africa/horn-africa/somalia/b155-covid-19-somalia-public-health-emergency-electoral-minefield

6. Sanyaolu A, Okorie C, Marinkovic A, et l. Comorbidity and its Impact on Patients with COVID-19. *Sn Compr Clin Med* 2020;2:1.

7. Garba B, Zakaria Z, Salihu MD, et al. Breaking the cycle of the COVID-19 transmission: A challenge for Nigeria. *J Glob Health* 2020;10: 2.

8. Ames JL, Ferrara A, Avalos LA, et al. COVID-19 prevalence, symptoms, and sociodemographic disparities in infection among insured pregnant women in Northern California. *PLoS One* 2021;16:e0256891.

9. Khalil A, Von Dadelszen P, Draycott T, et al. Change in the Incidence of Stillbirth and Preterm Delivery During the COVID-19 Pandemic. *JAMA* 2020;324:705.

10. Molenaar NM, Rommel AS, de Witte L, et al. Seroprevalence of SARS-CoV-2 during pregnancy and associated outcomes: results from an ongoing prospective cohort study, New York City. *MedRxiv* 2021;3:13.

11. Esteban-Gonzalo S, Caballero-Galilea M, González-Pascual JL, et al. Anxiety and Worries among Pregnant Women during the COVID-19 Pandemic: A Multilevel Analysis. *Int J Environ Res Public Health* 2021;18:13.

12. Federal Government of Somalia, Federal Member States, UNFPA Somalia. The Somali Health & Demographic Survey 2020. Somalia National Bureau of Statistics. [cited 2021 Nov 17]. Available from: https://www.nbs.gov.so/somali-health-demographic-survey-2020/

13. Kevadiya BD, Machhi J, Herskovitz J, et al. Diagnostics for SARS-CoV-2 infections. *Nat Mater* 2021;20:593–605.

14. Liu R, Han H, Liu F, et al. Positive rate of RT-PCR detection of SARS-CoV-2 infection in 4880 cases from one hospital in Wuhan, China, from Jan to Feb 2020. *Clin Chim Acta* 2020;1:172–5.

15. Lagerqvist N, Maleki KT, Verner-Carlsson J, et al. Evaluation of 11 SARS-CoV-2 antibody tests by using samples from patients with defined IgG antibody titers. *Sci Reports* 2021;11: 1–8.

16. Batra M, Tian R, Zhang C, et al. Role of IgG against N-protein of SARS-CoV2 in COVID19 clinical outcomes. *Sci Reports* 2021;11:1–9.

17. Abdi A, Ahmed AY, Abdulmunim M, et al. Preliminary findings of COVID-19 infection in health workers in Somalia: A reason for concern. *Int J Infect Dis* 2021;104:734.

18. Atnafie SA, Anteneh DA, Yimenu DK, et al. Assessment of exposure risks to COVID-19 among frontline health care workers in Amhara Region, Ethiopia: A cross-sectional survey. *PLoS One* 2021;16:e0251000.

19. Arakaki T, Hasegawa J, Sekizawa A, et al. Clinical characteristics of pregnant women with COVID-19 in Japan: a nationwide questionnaire survey. *BMC Pregnancy Childbirth* 2021;21:1–8.

20. Ejaz H, Alsrhani A, Zafar A, et al. COVID-19 and comorbidities: Deleterious impact on infected patients. *J Infect Public Health* 2020;13:1833.

21. WHO. Coronavirus disease (COVID-19): Situation Report, 141. 2020. [cited 2021 Nov 14]. Available from: https://apps.who.int/iris/handle/10665/332390

22. Crovetto F, Crispi F, Llurba E, et al. Seroprevalence and clinical spectrum of SARS-CoV-2 infection in the first versus third trimester of pregnancy. *MedRxiv* 2020; 2020:20134098.

23. Lopez M, Hawkins-Villarreal A, Goncé A, et al. OP03.02: Clinical spectrum of COVID-19 infection throughout gestation. *Ultrasound Obstet Gynecol* 2021;58:65–65.

24. Eastin C, Eastin T. Clinical Characteristics of Coronavirus Disease 2019 in China. *J Emerg Med* 2020;58:711.

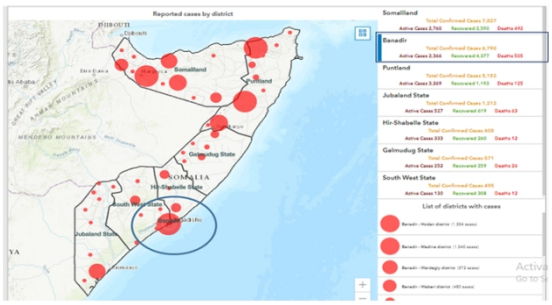
25. Mohamud MFY, Mohamed YG, Ali AM, et al. Loss of Taste and Smell are Common Clinical Characteristics of Patients with COVID-19 in Somalia: A Retrospective Double Centre Study. *Infect Drug Resist* 2020;13:2631.

26. Larsen JR, Martin MR, Martin JD, et al. Modeling the Onset of Symptoms of COVID-19. *Front Public Heal* 2020;13:473.

27. Arkhipova-Jenkins I, Helfand M, Armstrong C, et al. Antibody Response After SARS-CoV-2 Infection and Implications for Immunity: A Rapid Living Review. *Ann Intern Med* 2021;174:811–21.

Figure 1: Map of Somalia showing the COVID-19 cases and death (13/11/2021) with the study area (Benadir region) having the second highest number of confirmed cases (6,798) and the highest mortality (505). https://covid19som-ochasom.hub.arcgis.com/

Figure 2: Overall prevalence of SARS-CoV-2 virus antibodies among pregnant women in Mogadishu, Somalia



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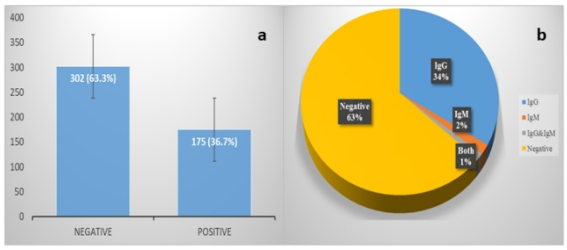

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	4
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	6-12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	-

		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Seroprevalence of SARS-CoV-2 virus antibodies and sociodemographic features of pregnant women in Mogadishu, Somalia

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Complete List of Authors:	Sh. Nur, Maryan Abdullahi ; SIMAD University, 1. Department of Obstetrics and gynecology, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Dahie, Hassan Abdullahi; SIMAD University, 3. Department of Nursing and Midwifery, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Hasan, Nimca Abdi ; Jazeera university, 7. Department of Obstetrics and gynecology, Jazeera university teaching hospital, Faculty of Medicine, Jazira University, Mogadishu, Somalia. Garba, Bashiru ; Usmanu Danfodiyo University, 6. Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, Usmanu Danfodiyo University Sokoto, Nigeria. Adam, Mohamed Husein Adam; SIMAD University, 4. Department of Public Health, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Mohamoud, Jamal Hassan; SIMAD University, 4. Department of Public Health, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Dirie, Najib Isse; SIMAD University, Urology department, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences
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Seroprevalence of SARS-CoV-2 virus antibodies and sociodemographic features of pregnant women in Mogadishu, Somalia

Maryan Abdullahi Sh. Nur[1], Hasan Abdullahi Dahie[3], Nimca Abdi Hasan[7], Bashiru Garba[5,6], Mohamed Husein Adam[4], Jamal Hasan Mohamoud[4], Najib Isse Dirie[2]

1. Department of Obstetrics and Gynecology, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
2. Department of Urology, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
3. Department of Nursing and Midwifery, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
4. Department of Public Health, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
5. Institute for Medical Research, SIMAD University, Mogadishu, Somalia.
6. Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, Usmanu Danfodiyo University Sokoto, Nigeria.
7. Department of Obstetrics and Gynecology, Jazeera University Teaching Hospital, Faculty of Medicine, Jazeera University, Mogadishu, Somalia.

***Corresponding author:** Najib Isse **DIRIE**; E-mail: drnajib@simad.edu.so.

ABSTRACT

Objective: Recent investigations have revealed that COVID-19 during pregnancy substantially increase the risk of harmful outcomes for mothers and neonates including pre-term death and stillbirth, as well as severe maternal morbidity and mortality. Hence, the urgent need to understand the prevalence rate and level of awareness about COVID-19 (SARS-CoV-2 virus infection) and the practice of preventive measures against the disease among pregnant women in Somalia. This study aims to determine the prevalence of COVID-19 among pregnant women seeking antenatal care in the Benadir region (Mogadishu) of Somalia and to assess their knowledge and preventive practices towards COVID-19.

Setting: A hospital-based cross-sectional study involving two major referral maternity hospitals in Mogadishu, Somalia.

Participants: Pregnant women seeking antenatal services were included in our study.

Methods: A total of 477 blood samples were collected from pregnant women attending the two referral hospitals in Mogadishu and screened for COVID-19. The participants were subjected to questionnaire interviews where their detailed history and practice of prevention against COVID-19 were evaluated.

Results: The results showed that 175 (36.7%) were positive while 302 (63.3%) samples were negative for SARS-CoV-2 virus antibodies. Also, out of the 141 pregnant women who had two children or less, 19.4% were positive for IgG/IgM antibodies. Participants who had close contact with COVID-19 patients were significantly associated for testing positive with a p-value 0.0001. Students, teachers, employed people, and individuals reported COVID-19 like symptoms were all associated with COVID-19 seropositivity outcomes.

Conclusion: Pregnant women, and those with commorbidies should be given special preventive care and health education about COVID-19 transmission.

Strength and limitation of the study:

- We were able to determine the prevalence of COVID-19 infection among pregnant women in Mogadishu, Somalia with 97.8% specificity.

- The results indicate that multiple birth, and smoking to be potential risk factors for COVID-19 among pregnant women.
- Majority of the pregnant women suffer chronic infection as a result of the predominance of IgG antibodies.
- Despite the 97.1% sensitivity and 97.8% specificity of the test kit, the RT-PCR is still superior in terms of detection of active infection.
- There is also the possibility of cross-reactivity with other corona virus antibodies in circulation.

Keywords: Seroprevalence; COVID-19; Anti-SAR-COV-2 antibodies; Pregnancy; Mogadishu; Somalia.

INTRODUCTION

Since the announcement of the COVID-19 (SARS-CoV-2 virus infection) outbreak as a public health emergency of international concern and its subsequent proclamation as a pandemic in the year 2020, the dramatic loss of human life and the associated public health and socio-economic challenges that ensued has been devastating. As of 1 December, 2021, the number of confirmed COVID-19 cases globally stands at 262,178,403, with 5,215,745 deaths [1]. Interestingly, the African continent has the least cases compared to the Americas, Europe, or Asia, despite its seeming poor public health system. Similarly, the case-fatality ratio for COVID-19 in Africa is lower than the global case-fatality ratio, which also implies that the outcome of the SARS-CoV-2 virus infection has been less severe among African populations [2]. Despite, the low number of confirmed cases in the continent being attributed to the low testing rates, which has continued to undermine the continental response [3]. Nonetheless, other factors that have been reported to contribute to the low incidence and mortality rate in Africa are; cross immunity with malaria, lower population mean age, lower number of individuals with comorbidities like cardiovascular diseases as well as lower pre-COVID-19 era '65yr+ mortality rate' [4,5]. Notwithstanding these apprehensions, there is no evidence that a large number of COVID-19 deaths have been missed; instead, the low numbers of confirmed cases can be attributed in part to the lessons learned

during the handling of several infectious disease outbreaks that have occurred in the continent including Yellow fever, Ebola, HIV, and AIDS [6].

Despite having one of Africa's most fragile health care systems, occasioned by the ongoing conflict and destruction of public health infrastructure, the number of cases in Somalia is relatively low. However, cases have in recent months increased tenfold, and there are indications of community transmission beyond the major cities [7]. The risk of acquiring COVID-19 is known to be higher among the elderly as well as individuals with underlying comorbidities, including moderate to severe asthma, diabetes, cardiovascular diseases, and other respiratory illnesses, including pregnancy which predisposes to severe illness [8–10]. The pandemic has disproportionately impacted vulnerable groups such as persons with disabilities and internally displaced people living in makeshift camps in Somalia. The above has been driven by the non-adherence to the outlined public health measures and has contributed significantly to the increasing number of cases recorded in the country.

Until recently, many studies have shown that pregnant women do not seem to be at a higher risk of getting COVID-19 [11]. In other words, being pregnant does not increase the chances of getting COVID-19 more than non-pregnant persons; however, recent studies have shown that COVID-19 during pregnancy is associated with severe outcomes such as high rate of maternal morbidity and mortality, and neonatal complications [12–14]. There are also emerging evidence that the risk of having stillbirth may be higher among pregnant COVID-19 patients [15]. These pre-neonatal and neonatal period complications are attributed to pregnant women's reduced respiratory capacity, low immunity, and the hemodynamic changes they undergo. The risk of severe maternal outcomes is even higher if they have pulmonary comorbidities, hypertensive disorders, and diabetes mellitus [16]. Moreover, investigations have shown women to be a vulnerable group during the COVID-19 pandemic. This worry is even more among pregnant women who occasionally experience pregnancy and postpartum mental illnesses (depression, anxiety, and postpartum psychosis), resulting in bipolar disorder [17]. These situations are a cause for concern in Somalia, whose women of reproductive age represent 38% of the household, with a worrying maternal mortality rate of 692 [18]. Also, among the 23,102 cases as of 2/12/2021, 26% (amounting >6006 cases) are female.

The main strategy for each country is to vaccine their general public against COVID-19; the WHO and all governments around the globe are doing their best efforts and advocacy for mass vaccination. To date, a total of 7,772,799,316 vaccine doses have been done according to the data released daily by the WHO. The Ministry of health (MoH) of the federal government of Somalia has been vaccinating the public since 2020 based on vaccines donated by international organizations and some governments. Since the vaccination program started, the MoH was hesitant to vaccinate pregnant women for lack of evidence; however, on 18 November 2021, they released a newsletter stating that MoH recommends vaccinating pregnant women with a single dose J&J COVID-19 vaccine after the first trimester.

This survey was conducted among pregnant women to study if they were exposed to COVID-19 based on the *OnSite* COVID-19 IgG/IgM Rapid Test that detects anti-SARS-CoV-2 IgG and IgM antibodies in serum and plasma. The aim was to estimate the prevalence of diagnosed COVID-19 among pregnant women in Somalia's Benadir region. Also, a questionnaire was administered to consenting participants to determine demographic characteristics and potential risk factors for COVID-19. We also intend to evaluate the presence or otherwise of any association between the participants sociodemographic features with their respective COVID-19 status.

MATERIAL AND METHODS

Study Design: We present a cross-sectional study aiming to estimate the Seroprevalence of SARS-CoV-2 antibodies among pregnant women attending referral hospitals in Mogadishu, Somalia, from July 31st 2021 to August 31st 2021 (**Figure 1**). Women who indicated their informed consent and had no history of COVID-19 vaccination were included in the survey. Participants who did not consent to participate in the study were excluded.

Study Setting: The selected hospitals are the major two referral hospitals for mother and child in the capital city of Mogadishu. Both hospitals are located on either side of the city and routinely offer free medical services to the mother and child. One hospital in the south provides services to the most vulnerable in the society, mainly the internally displaced people (IDP) from the regions in the south of Somalia. And the other hospital located in the north of the city covers the city's

north districts, including patients from nearby central Somalia regions. The consenting participants were administered a questionnaire covering demographics, obstetrical history, general health status, COVID-19 status, and COVID-19 preventive measures. The questionnaire was prepared using Google form for ease of use, processing, and analyzing the data generated.

Sample size determination

We assumed a 50% prevalence since no study had previously been done to determine the Seroprevalence of COVID-19 antibodies among pregnant women in Somalia.

Therefore, based on the Cochran's formula for sample size calculation ($N = Z^2 \times P\ (1\text{-}P) \div \varepsilon^2$)

Where, Z is 1.96 (constant), e is the desired level of precision (i.e. 5% margin of error at 95% confidence interval), p estimated prevalence (5.7%), and q is 1 – p.

Therefore

$N = Z^2 \times P\ (1\text{-}P) \div \varepsilon^2$

$N = 3.8416 \times 0.5\ (1\text{-}0.5) \div 0.0025$

$N = 384.16$ samples

However, in order to increase our chances of detection, 477 samples were collected.

Serological Testing: Participants were tested with the CTK BIOTECH's *OnSite* COVID-19 IgG/IgM Rapid Test (California, USA) following the instructions given by the manufacturer. The *OnSite* COVID-19 IgG/IgM Rapid Test is suitable for detecting individuals with recent or latent infection to SARS-CoV-2 virus infection, indicating recent or prior infection. The *OnSite* COVID-19 IgG/IgM Rapid Test is one of the most effective test for detecting previous exposure to SARS-CoV-2 virus infection virus with a 97.1% sensitivity and 97.8% specificity.

Four trained doctors, assisted by three junior doctors, and a final year obstetrician-gynecology postgraduate student participated in the blood sample collection and filling of the Google form questionnaires according to inputs from the participants (pregnant women attending antenatal services). Participants were given a detailed explanation of the study purpose and procedure, while the confidentiality of their data was granted.

The study's primary outcome was the seroprevalence of IgG & IgM-specific antibodies in a cohort of pregnant women during the study period. In our analysis, we stratified the population according to the results of the serological study (IgG, IgM, & IgG/IgM positive vs. negative

group). Those with positive IgG/IgM were further subdivided depending on the presence or absence of COVID-19 related risky behaviors, obstetrical characteristics, history of chronic illnesses, and COVID-19 symptoms at any time before the serological study using descriptive and inferential analysis.

Statistical Analysis: For the descriptive analysis, the general distribution of all the variables included in this study was assessed by frequency and percentages for categorical variables and means and standard deviations for continuous data using SPSS statistical software version 25. For inferential analysis, we used logistic regression to examine the relationship between predictor variables and the outcome variables.

Patient and Public Involvement: It was not appropriate or possible to involve patients or the public in the design, or conduct, or reporting, or dissemination plans of our research.

Research Ethics Approval: The investigation commenced after Our Institutional Review Board approved all study procedures (SIMAD University Ethics Committee. **ID:** IMRSU/FMHS (FR18) P003).

RESULTS

From July 31st 2021 to August 31st 2021, a total of 477 eligible pregnant women were tested for SARS-COV-2 VIRUS INFECTION specific antibodies. The single-use lateral flow immunoassay test kit is used for detection and differentiation of anti-SARS-CoV-2 virus infection IgG and IgM immunoglobulins where a total of 302 (63.3%) serum samples were found to be negative for SARS-CoV-2 virus infection while 175 (36.7%) turned out to be positive (**Figure 2a**). Similarly, 34% of the circulating antibodies were IgG indicating long-term infection, while IgM circulation was found in only 2% of the women (**Figure 2b**).

The COVID-19-related sociodemographic characteristics analyzed, including age, education level, and the number of people in the household, were all found not to be statistically significant (p>0.05). However, other demographics studied like marital status, divorced women who were pregnant were more likely (22%) to contract COVID-19 (**Table 1**). Similarly, in terms of the level of education, being a student, a teacher, or employed were found to be statistically significant risk factors for contracting COVID-19 with p-values of 0.009, 0.027, 0.003, respectively. Important to note that, statistical significance in this case does not equate causation, rather, it implies increased risk.

Table 1: Socio-demographic characteristics of pregnant women in Mogadishu, Somalia

Demographics	N	COVID-19 (IgG/IgM)		OR at 95%CI	P value
		Positive (175)	Negative (302)		
Age					
15-19 years	92	31 (17.7)	61 (20.2)	Ref.cat	
20-24 years	121	41 (23.4)	80 (26.5)	0.992(0.559-1.759)	0.977
>24 years	264	103 (58.9)	161 (53.3)	0.794(0.483-1.307)	0.365
Marital status					
Married	341 (71.5)	109 (62.3)	232 (76.8)	Ref.cat	
Divorced	106 (22.2)	56 (22.0)	50 (16.6)	0.419(0.269-0.654)	0.0001*
Widowed	30 (6.3)	10 (5.7)	20 (6.6)	0.940(0.425-2.076)	0.878
Educational level					
Informal	267	83 (47.4)	184 (60.9)	1.260(0.723-2.194)	0.415
Primary	39	16 (9.1)	23 (7.6)	0.817(0.365-1.827)	0.622
High school	102	51 (29.1)	51 (16.9)	0.568(0.304-1.062)	0.077
University	69	25 (14.3)	44 (14.6)	Ref.cat	
Occupation					
Student	74 (15.5)	34 (19.4)	40 (13.2)	0.500(0.296-0.843)	0.009*
Teacher	11 (2.3)	7 (4.0)	4 (1.3)	0.243(0.069-0.851)	0.027*
Employed	107 (22.4)	49 (28.0)	58 (19.2)	0.503(0.318-0.795)	0.003*
Unemployed	285 (59.7)	85 (48.6)	200 (66.2)	Ref.cat	
No. of household					
1-5	103 (21.6)	32 (18.3)	71 (23.5)	Ref.cat	
6-10	213 (44.7)	82 (46.9)	131 (43.4)	0.720(0.437-1.188)	0.198
>10	161 (33.8)	61 (34.9)	100 (33.1)	0.739(0.437-1.249)	0.258

* Statistically significant at the 0.05 level

According to the obstetrical characteristics of the respondents, 34 (19.4%) of women who reported they had given birth to less than two children were found to have circulating levels of SARS-CoV-2 antibodies, and this result was statistically significant at p=0.0001. While the other variables (history of abortion and stage of gestation) were not a potential risk factor to acquiring COVID-19 since none of them was found to be significant (**Table 2**).

Table 2: Obstetric characteristics of pregnant women in Mogadishu, Somalia

Characteristic	N	COVID-19 IgG/IgM test		OR 95%CI	P value
		Positive (175)	Negative (302)		
Parity					
0-2	141 (29.6)	34 (19.4)	107 (35.4)	0.439(0.289-0.684)	0.0001*
>2	336 (70.4)	141 (80.6)	195 (64.6)	Ref.cat	
History of abortion					
Yes	105 (22.0)	35 (20.0)	70 (23.2)	0.829(0.525-1.308)	0.420
No	372 (78.0)	56 (22.0)	50 (16.6)	Ref.cat	
Gestational age					
<13 weeks	65 (13.6)	29 (16.6)	36 (11.9)	Ref.cat	0.127
14-26 weeks	92(19.3)	30(17.1)	62 (20.5)	1.665(0.865-3.205)	0.206

* Statistically significant at the 0.05 level

Some of the unhealthy behaviors reported to increase the risk of other respiratory illnesses were also evaluated in this study. Notable among them is the smoking of cigarettes, Shisha, and the local habit of chewing Khat (*Catha edulis*), a stimulant plant frequently chewed among Somalis. Among these, only the smoking of shisha (4.6% positive) was found to pose a risk for contracting COVID-19 infection due to sharing of pipes.

Furthermore, human-to-human transmission of COVID-19 is precipitated by close contact with family members and is usually high when the number of families in a household is considerable. In order to evaluate the association between the number of people in the household with the risk of contracting the infection, participants were asked questions relating to knowledge about their COVID-19 status, familiarity with the basic clinical signs of COVID-19, the possibility of transmission within family members as well as observance of public health preventive measures (**Table 3**).

Table 3: COVID-19 status among pregnant women in Mogadishu, Somalia

Characteristic	N	COVID-19 (IgG/IgM)		OR 95%(CI)	P value
		Positive (175)	Negative (302)		
Were you ever tested for COVID-19?					
Yes	139 (29.1)	67 (38.3)	72 (23.8)	1.982(1.324-2.967)	0.001*
No	338 (70.9)	108 (61.7)	230 (76.2)	Ref.cat	
What was the result?					
Positive	55 (11.6)	34 (19.5)	21 (7.0)	0.283(0.156-0.511)	0.0001*
Negative	96 (20.2)	38 (21.8)	58 (19.2)	0.698(0.436-1.119)	0.135
Not applicable	325 (68.3)	102 (58.6)	223 (73.8)	Ref.cat	
Have you ever had COVID-19?					
Yes	102 (21.4)	60 (34.3)	42 (13.9)	0.639(0.385-1.060)	0.083
No	222 (46.5)	42 (24.0)	180 (59.6)	3.911(2.464-6.207)	0.0001*
Not sure	153 (32.1)	73 (41.7)	80 (26.5)	Ref.cat	
Did you have COVID-19 symptoms?					
Yes	193 (40.5)	126 (72.0)	67 (22.2)	9.019(5.883-13.827)	0.0001*
No	284 (59.5)	49 (28.0)	235 (77.8)	Ref.cat	
Did you have fever?					
Yes	212 (44.4)	130 (74.3)	82 (27.2)	7.751(5.076-11.836)	0.0001*
No	265 (55.6)	45 (25.7)	220 (72.8)	Ref.cat	
Did you have cough?					
Yes	216 (45.3)	138 (78.9)	78 (25.8)	10.711(6.864-16.715)	0.0001*
No	261(54.7)	37 (21.1)	224 (74.2)	Ref.cat	
Did you lose your smell?					
Yes	180 (37.7)	127 (72.6)	53 (17.5)	12.430(7.964-19.401)	0.0001*
No	297 (62.3)	48 (27.4)	249 (82.5)	Ref.cat	
Did you lose your taste?					
Yes	166 (34.8)	118 (67.4)	48 (15.9)	10.955(7.043-17.038)	0.0001*
No	311 (65.2)	57 (32.6)	254 (84.1)	Ref.cat	
Did you have stomach upset?					
Yes	135 (28.3)	103 (58.9)	32 (10.6)	12.070(7.512-19.395)	0.0001*
No	342 (71.7)	72 (41.1)	270 (89.4)	Ref.cat	
Did you have shortness of breath?					
Yes	170 (35.6)	122 (69.7)	48 (15.9)	12.181(7.796-19.031)	0.0001*
No	307 (64.4)	53 (30.3)	254 (84.1)	Ref.cat	
When was the time you had the symptoms					
<3 months	87 (18.2)	48 (27.4)	39 (12.9)	0.075(0.039-0.0146)	0.0001*
3-6 months	35 (7.3)	22 (12.6)	13 (4.3)	0.055(0.023-0.129)	0.0001*
>6 months	166 (34.8)	89 (50.9)	77 (25.5)	0.080(0.044-0.145)	0.0001*
Not applicable	189 (39.6)	16 (9.1)	173 (57.3)	Ref.cat	
Close contact with someone having COVID-19					
Yes	158 (33.1)	110 (62.9)	48 (15.9)	0.218(0.117-0.407)	0.0001*
No	256 (53.7)	44 (25.1)	212 (70.2)	2.409(1.201-4.462)	0.005*
Not sure	63 (13.2)	21 (12.0)	42 (13.9)	Ref.cat	
Did any household contact colleagues or close friend had COVID-19?					
Yes	195 (40.9)	126 (72.0)	69 (22.8)	8.683(5.674-13.288)	0.0001*
No	282 (59.1)	49 (28.0)	233 (77.2)	Ref.cat	
Was anyone of your close contacts hospitalized for COVID-19					
Yes	169 (35.4)	115 (65.7)	54 (17.9)	8.802(5.732-13.518)	0.0001*
No	308 (64.6)	60 (34.3)	248 (82.1)	Ref.cat	

Did anyone of your close contacts die of COVID-19?					
Yes	182 (38.2)	124 (70.9)	58 (19.2)	10.229(6.628-15.785)	0.0001*
No	295 (61.8)	51 (29.1)	244 (80.8)	Ref.cat	

* Statistically significant at the 0.05 level

A total of 193 pregnant women reported having had COVID-19 infection, out of which 126 (72%) presented clinical signs indicative of the disease while asymptomatic were 67(22.2%). The most common symptom presented by the infected women were cough (78.9%), fever (74.3%), shortness of breath (69.7%), loss of smell (72.6%), and stomach upset (58.9%). The timing of symptoms appearing differed significantly between gestations, first trimester (27.4%), second trimester (12.6%), and third trimester (50.9%). Close contact with a family member of someone who had COVID-19 was also a significant finding for testing positive with a p-value =0.004. We also observed that the number of close contacts the respondents knew who had A total of 193 pregnant women reported having had COVID-19 infection out of which 126 (72%) presented clinical signs indicative of the disease while asymptomatic were 67(22.2%). The most common symptom presented by the infected women were cough (78.9%), fever (74.3%), shortness of breath (69.7%), loss of smell (72.6%), and stomach upset (58.9%). The timing of symptoms appearing differed significantly between gestations, first trimester (27.4%), second trimester (12.6%), and third trimester (50.9%). Close contact with a family member of someone who had COVID-19 was also a significant finding for testing positive with a p-value =0.004. We also observed that the number of close contacts the respondents knew whom COVID-19 had was more likely hospitalized (65.7%) or died of the infection (70.9%).

Observing social and physical distances was statistically significant compared with not observing this essential preventive measure (**Table 4**). The result revealed that 41.7% of the respondents admitted to observing distancing among others (168), which is lower than the number of respondents that admitted to not practicing distancing (308), and this was found to be statistically significant ($p<0.05$). Except for the use of face mask, which showed the number of those using it (268) was higher than those not using (209), the adherence to other preventive measures was poor, particularly frequent hand washing, which showed 53.1% not practicing handwashing compared to 46.9% that claimed they regularly wash their hands. Importantly, this finding was not statistically significant; however, the odds are greater than 1, implying that not adhering to these preventive measures could increase the chances of contracting COVID-19.

Table 4: Preventive measures observed by the of pregnant women in Mogadishu, Somalia

Characteristic	N	COVID-19 (IgG/IgM)		OR 95%CI	P value
		Positive (175)	Negative (302)		
Do you regularly wear face mask?					
Yes	268 (56.2)	108 (61.7)	160 (53.0)	Ref.cat	
No	209 (43.8)	67 (38.3)	142 (47.0)	1.431(0.979-2.091)	0.064
If "yes", what types of mask do you wear?					
N95	43 (9.0)	18 (10.3)	25 (8.3)	Ref.cat	
Surgical face mask	79 (16.6)	23 (13.1)	56 (18.5)	1.753(0.807-3.810)	0.156
Others	163 (34.2)	70 (40.0)	93 (30.8)	0.957(0.484-1.889)	0.898
Not applicable	192 (40.3)	64 (36.6)	128 (42.4)	1.440(0.732-2.831)	0.290
Do you regularly wash your hands					
Yes	205 (43.0)	82 (46.9)	123 (40.7)	Ref.cat	
No	272 (57.0)	93 (53.1)	179 (59.3)	1.283(0.882-1.868)	0.193
Do you keep your distance from others					
Yes	168 (35.2)	73 (41.7)	95 (31.5)	Ref.cat	
No	309 (64.8)	102 (58.3)	207 (68.5)	1.643(0.903-2.988)	0.104
Do you avoid handshaking?					
Yes	164 (34.4)	66 (37.7)	98 (32.5)	Ref.cat	
No	313 (65.6)	109 (62.3)	204 (67.5)	0.858 (0.484-1.520)	0.599

* Statistically significant at the 0.05 level

Comorbidities of pregnant women with confirmed SARS-CoV-2 virus infection are shown in **Table 5**. There was a significant difference in mean between the COVID-19-positive pregnant women and COVID-19 negative pregnant women across all the comorbidities inquired (diabetes, hypertension, cardiovascular disease, and asthma) with a p-value of 0.001. The odds ratio was also greater than 1, which means greater odds of association with having any chronic illness and the chances of becoming infected with COVID-19.

Table 5: Comorbidities of pregnant women with conformed SARS-CoV-2 virus infection

Characteristic	N	COVID-19 (IgG/IgM)		OR 95%CI	P value
		Positive (175)	Negative (302)		
Do you have diabetes?					
Yes	94(19.7)	50 (28.6)	44 (14.6)	2.345(1.484-3.708)	0.0001*

No	383 (80.3)	125(71.4)	258 (85.4)	Ref.cat	
Do you have hypertension?					
Yes	124 (26.0)	67 (38.3)	57(18.9)	2.667(1.753-4.056)	0.0001*
No	353 (74.0)	108 (61.7)	245 (81.1)	Ref.cat	
Do you have cardiac disease?					
Yes	85 (17.8)	46 (26.3)	39 (12.9)	2.811(1.721-4.590)	0.0001*
No	392 (82.2)	129 (73.7)	263 (87.1)	Ref.cat	
Do you have asthma?					
Yes	85 (17.8)	46 (26.3)	39 (12.9)	2.405(1.494-3.870)	0.0001*
No	392 (82.2)	129 (73.7)	263 (87.1)	Ref.cat	
Do you have family history of hypertension?					
Yes	137 (28.7)	63 (36.0)	74 (24.5)	1.733(1.156-2.598)	0.008*
No	340 (71.3)	112 (64.0)	228 (75.5)	Ref.cat	
Do you have family history of diabetes?					
Yes	148 (31.0)	72 (41.1)	76 (25.2)	2.079(1.397-3.094)	0.0001*
No	329 (69.0)	103 (58.9)	226 (74.8)	Ref.cat	
Do you have family history of cardiac disease?					
Yes	155 (32.5)	76 (43.4)	79 (26.2)	2.167(1.461-3.213)	0.0001*
No	322 (67.5)	99 (56.6)	223 (73.8)	Ref.cat	
Do you have family history of asthma?					
Yes	137 (28.7)	64 (36.6)	73 (24.2)	1.809(1.206-2.712)	0.004*
No	340 (71.3)	111 (63.4)	229 (75.8)	Ref.cat	
Do you have family history of obesity?					
Yes	193 (40.5)	89 (50.9)	104 (34.4)	1.970(1.348-2.880)	0.0001*
No	284 (59.5)	86 (49.1)	198 (65.6)	Ref.cat	
Do you take regular medications?					
Yes	137 (28.7)	66 (37.7)	71 (23.5)	0.494(0.328-0.744)	0.001*
Herbal medication	19 (4.0)	8 (4.6)	11 (3.6)	0.631(0.246-1.617)	0.338
No	321 (67.3)	101 (57.7)	220 (72.8)	Ref.cat	

* Statistically significant at <0.05

DISCUSSION

This study investigated the prevalence, knowledge, and preventive practices towards COVID-19 among pregnant women seeking antenatal services in two of the major public hospitals in Mogadishu, within the Benadir region of Somalia. This study coincided with the third wave of the COVID-19 outbreak in Somalia around early July 2021. During this period, a total of 477 pregnant women were screened for confirmation of COVID-19 using the CTK BIOTECH's *OnSite* COVID-19 IgG/IgM Rapid Test kit which is capable of identifying SARS-CoV-2 antibodies with 97.1% and 97.8% sensitivity and specificity respectively [19]. To date, the most reliable method of detecting SARS-CoV-2 virus infection is RT-PCR [20,21]. Nonetheless, the

OnSite COVID-19 IgG/IgM Rapid Test can identify individuals with circulating antibodies against the SARS-CoV-2 virus infection virus either as a result of recent or prior infection [19]. In this study, the predominant immunoglobulin among the COVID-19 positive pregnant women was IgG with 34% circulation followed by IgM with 2%. During the acute phase of COVID-19 infection, IgM blood levels against SARS-CoV-2 virus infection rise rapidly and peak after 2-3 weeks of contracting the virus, followed by SARS-CoV-2 virus infection specific IgG antibodies appear and persist in the circulation for months. The majority of the COVID-19 positive pregnant women sampled had a chronic long-term infection. This outcome is similar to the previous report where titers of IgG targeting N-protein of SARS-CoV2 was recommended as a prognostic factor in understanding the clinical course of COVID-19 and that it should be measured in all patients with SARS-CoV2 infection [22].

The overall prevalence of SARS-CoV-2 virus infection among pregnant women was 36.7%, with 3% of the total having an active infection, but none needed critical care. Even though earlier studies have reported a prevalence of 61% among healthcare workers, the 36.7% recorded in this study is distressing, this is because the 61% we referred to was from a study conducted among healthcare workers in Somalia [23]. It is not a surprise to see a high number of cases among this category of people because they constitute the frontline workers at the most significant risk of contracting the disease [24]. This figure (36.7%) is considerably high when studies were done in Japan and New York, which found a seroprevalence of 0.03% and 16.4%, respectively [16,25].

Concerning the adherence to the outlined preventive measures, including avoiding crowd, frequent washing of hands with detergents or disinfectants, and the use of face coverings, we observed a worrying trend where the majority of the respondents admitted to not practicing these aforementioned public health guidelines with an increased odd of contracting the disease as a result (OR>1). This undesirable habit of not adhering to the recommended preventive practice may give further credence to the high number of positive cases recorded in this study. We understand that observing these set-out regulations will be challenging and complex because of some Somali culture and traditions of congregating, sharing hugs, and shaking hands. Nonetheless, considering the vulnerabilities of pregnant women, there is an urgent need to ensure compliance with these COVID-19 requirements; otherwise, things may only worsen for pregnant women in Somalia. It is important to point out that, based on the results of this study, no

difference in terms of increased risk was observed between wearing mask and not wearing. This may not however be surprising because public mask wearing is most effective at reducing spread of the virus when the recommended mask is worn properly with high compliance [26]. Additionally, because wearing masks has been reported to bring down the overall risk of spreading COVID-19, people have become careless and less likely to abide by standard measures and more willing to take other risks, such as decreasing the physical distance between them and others. Furthermore, despite the results showing no risk of contracting infection regardless of whether a mask is worn or not, in contrast to the popular report on face covering, it is likely that this discrepancy may be because of the careless attitude among people wearing mask for the mere believe that the mask will protect them. Interestingly, only 25.6% of those that claimed they wear mask reported they used the recommended mask (N95-9% and surgical mask 16.6%). The remaining reported wearing masks made of simple clothes while others considered Islamic face veil (Niqab) to be enough face mask for COVID-19 prevention.

Additional vital findings in this study are the relationship of COVID-19 positive status and comorbidity. Since the first outbreak, we have come to realize that SARS-CoV-2 infects people of all age groups; however, elderly people (above 60 years), as well as individuals with comorbidities such as chronic respiratory disease (asthma patients), diabetes and cardiovascular diseases, are at a greater risk of developing infection with severe outcomes [27,28]. Although most of the respondents admitted to not having any of the chronic disease conditions asked, viz hypertension, diabetes, asthma, cardiovascular disease, and obesity (74-82%). Nevertheless, many pregnant women (17.8-28.7%) indicated they have one or more of these comorbidities, as mentioned earlier, which will increase the risk for them and their unborn children.

Other potential risk factors evaluated in this study, such as parity, history of abortion, stage of gestation, and some unhealthy behaviors like smoking, revealed no significant relationship concerning increasing chances of contracting COVID-19 among pregnant women, with an odds ratio of 0.4 to 0.8. However, the risk for contracting the disease for smokers of Shisha was very high with an odds ratio of 3.569, and this finding was statistically significant (p=0.04). Like other studies, none of the different trimesters of pregnancy was associated with a high risk of getting the infection. A study done in Spain found that Seroprevalence was similar between

women in the first trimester of pregnancy and women in the third trimester, suggesting a similar risk of infection. However, the proportion of women with symptoms and those requiring hospitalization was higher in the third-trimester group than in the first-trimester group [29,30]. On the other hand, available data have already indicated that smoking doubles the risk of having severe COVID-19 [31]. Lung damage from COVID-19 resembles the damage of smoke from cigarettes and other tobacco products that introduce particulate matter from the environment into the lungs. Notably, the mouthpiece and the hose in the shisha can serve as a means of transmission of the COVID-19 virus, which can also spread through shisha sharing.

Participants who reported COVID-like symptoms were more likely to turn positive when tested for COVID-19. Though some reported no history of COVID-19 infection, this wave arrived simultaneously with the already expected seasonal flue. The order and frequency of symptoms were almost the same with a study done in Mogadishu in which the most typical symptom reported was cough (>75%), followed by fever (>71%) and loss of taste and smell [32]. Other studies show that fever and cough were the most typical symptoms reported, followed by stomach upset [33]. We also observed that pregnant women who reported having had a previous infection with COVID-19 were more likely to test positive. Though COVID-19 specific immunity may disappear in three months, one may believe that since they were infected in previous waves, they still sustain immunity and do not practice preventive measures [34].

In conclusion, the COVID-19 high prevalence observed in this study is disturbing considering how vulnerable pregnant women can be, especially in Somalia, where the healthcare services face serious challenges. The poor attitude in observing preventive measures against COVID-19 among pregnant women also warrants serious attention towards raising awareness among midwives and health care workers who are in close contact with women delivering babies to reduce infection transmission and ensure prevention and control of the virus.

Author Contribution: Najib Isse Dirie, and Maryan Abdullahi Sh. Nur conceived the study and drafted the original protocol. Najib Isse Dirie, Hasan Abdullahi Dahie, Nimca Abdi Hasan, Mohamed Husein Adam, and Bashiru Garba, contributed to developing the survey questionnaires. Hasan Abdullahi Dahie, Jamal Hasan Mohamoud, and Bashiru Garba played a

major role in the statistical analyses. All the authors participated in, read and approved the final manuscript.

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References

1. Somalia: WHO Coronavirus Disease (COVID-19) Dashboard With Vaccination Data | WHO Coronavirus (COVID-19) Dashboard With Vaccination Data [Internet]. [cited 2021 May 25]. Available from: https://covid19.who.int/region/emro/country/so
2. Partnership for Evidence-Based Response to COVID-19 (PERC) - Prevent Epidemics [Internet]. [cited 2021 Nov 13]. Available from: https://preventepidemics.org/covid19/perc/
3. Chitungo I, Dzobo M, Hlongwa M, Dzinamarira T. COVID-19: Unpacking the low number of cases in Africa. Public Heal Pract [Internet]. 2020 Nov [cited 2021 Nov 13];1:100038. Available from: /pmc/articles/PMC7485446/
4. Osei SA, Biney RP, Anning AS, Nortey LN, Ghartey-Kwansah G. Low incidence of

COVID-19 case severity and mortality in Africa; Could malaria co-infection provide the missing link? BMC Infect Dis [Internet]. 2022 Dec 1 [cited 2022 Mar 14];22(1):1–11. Available from: https://bmcinfectdis.biomedcentral.com/articles/10.1186/s12879-022-07064-4

5. Lawal Y. Africa's low COVID-19 mortality rate: A paradox? Int J Infect Dis. 2021 Jan 1;102:118–22.

6. Nkengasong J. Let Africa into the market for COVID-19 diagnostics. Nature. 2020 Apr 30;580(7805):565–565.

7. COVID-19 in Somalia: A Public Health Emergency in an Electoral Minefield | Crisis Group [Internet]. [cited 2021 Nov 13]. Available from: https://www.crisisgroup.org/africa/horn-africa/somalia/b155-covid-19-somalia-public-health-emergency-electoral-minefield

8. Sanyaolu A, Okorie C, Marinkovic A, Patidar R, Younis K, Desai P, et al. Comorbidity and its Impact on Patients with COVID-19. Sn Compr Clin Med [Internet]. 2020 Aug [cited 2021 Nov 13];2(8):1. Available from: /pmc/articles/PMC7314621/

9. Garba B, Zakaria Z, Salihu MD, Bande F, Saidu B, Bala JA. Breaking the cycle of the COVID-19 transmission: A challenge for Nigeria. J Glob Health. 2020;10(2).

10. Adam MH, Mohamoud JH, Mohamood AS, Mohamed AA, Garba B, Dirie NI. Seroprevalence of Anti-SARS-CoV-2 Antibodies in Benadir Region, Somalia. Vaccines [Internet]. 2022 Jan 30 [cited 2022 Mar 1];10(2):220. Available from: /pmc/articles/PMC8877673/

11. Wang CL, Liu YY, Wu CH, Wang CY, Wang CH, Long CY. Impact of COVID-19 on Pregnancy. Int J Med Sci [Internet]. 2021 [cited 2022 Mar 14];18(3):763. Available from: /pmc/articles/PMC7797535/

12. Ames JL, Ferrara A, Avalos LA, Badon SE, Greenberg MB, Hedderson MM, et al. COVID-19 prevalence, symptoms, and sociodemographic disparities in infection among insured pregnant women in Northern California. PLoS One [Internet]. 2021 Sep 1 [cited 2021 Nov 13];16(9):e0256891. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0256891

13. Villar J, Ariff S, Gunier RB, Thiruvengadam R, Rauch S, Kholin A, et al. Maternal and Neonatal Morbidity and Mortality Among Pregnant Women With and Without COVID-19 Infection: The INTERCOVID Multinational Cohort Study. JAMA Pediatr [Internet]. 2021 Aug 1 [cited 2022 Mar 14];175(8):817–26. Available from: https://jamanetwork.com/journals/jamapediatrics/fullarticle/2779182

14. Iacobucci G. Covid-19: Severe infection in pregnancy significantly increases risks, study shows. BMJ [Internet]. 2022 Feb 24 [cited 2022 Mar 14];376:o480. Available from: https://www.bmj.com/content/376/bmj.o480

15. Khalil A, Von Dadelszen P, Draycott T, Ugwumadu A, O'Brien P, Magee L. Change in the Incidence of Stillbirth and Preterm Delivery During the COVID-19 Pandemic. JAMA [Internet]. 2020 Aug 18 [cited 2021 Nov 13];324(7):705. Available from:

/pmc/articles/PMC7435343/

16. NM M, A R, Ld W, SM D, W L, E I, et al. Seroprevalence of SARS-CoV-2 during pregnancy and associated outcomes: results from an ongoing prospective cohort study, New York City. 2021 Feb 3 [cited 2021 Nov 13]; Available from: https://europepmc.org/article/PPR/PPR277509

17. Esteban-Gonzalo S, Caballero-Galilea M, González-Pascual JL, Álvaro-Navidad M, Esteban-Gonzalo L. Anxiety and Worries among Pregnant Women during the COVID-19 Pandemic: A Multilevel Analysis. Int J Environ Res Public Health [Internet]. 2021 Jul 1 [cited 2021 Nov 13];18(13). Available from: /pmc/articles/PMC8297358/

18. Ahmed MAM, Fodjo JNS, Gele AA, Farah AA, Osman S, Guled IA, et al. COVID-19 in Somalia: Adherence to Preventive Measures and Evolution of the Disease Burden. Pathog 2020, Vol 9, Page 735 [Internet]. 2020 Sep 6 [cited 2021 Nov 13];9(9):735. Available from: https://www.mdpi.com/2076-0817/9/9/735/htm

19. Lagerqvist N, Maleki KT, Verner-Carlsson J, Olausson M, Dillner J, Wigren Byström J, et al. Evaluation of 11 SARS-CoV-2 antibody tests by using samples from patients with defined IgG antibody titers. Sci Reports 2021 111 [Internet]. 2021 Apr 7 [cited 2021 Nov 14];11(1):1–8. Available from: https://www.nature.com/articles/s41598-021-87289-6

20. Kevadiya BD, Machhi J, Herskovitz J, Oleynikov MD, Blomberg WR, Bajwa N, et al. Diagnostics for SARS-CoV-2 infections. Nat Mater 2021 205 [Internet]. 2021 Feb 15 [cited 2021 Nov 14];20(5):593–605. Available from: https://www.nature.com/articles/s41563-020-00906-z

21. Liu R, Han H, Liu F, Lv Z, Wu K, Liu Y, et al. Positive rate of RT-PCR detection of SARS-CoV-2 infection in 4880 cases from one hospital in Wuhan, China, from Jan to Feb 2020. Clin Chim Acta. 2020 Jun 1;505:172–5.

22. Batra M, Tian R, Zhang C, Clarence E, Sacher CS, Miranda JN, et al. Role of IgG against N-protein of SARS-CoV2 in COVID19 clinical outcomes. Sci Reports 2021 111 [Internet]. 2021 Feb 10 [cited 2021 Nov 14];11(1):1–9. Available from: https://www.nature.com/articles/s41598-021-83108-0

23. Abdi A, Ahmed AY, Abdulmunim M, Karanja MJ, Solomon A, Muhammad F, et al. Preliminary findings of COVID-19 infection in health workers in Somalia: A reason for concern. Int J Infect Dis [Internet]. 2021 Mar 1 [cited 2021 Nov 14];104:734. Available from: /pmc/articles/PMC7872860/

24. Atnafie SA, Anteneh DA, Yimenu DK, Kifle ZD. Assessment of exposure risks to COVID-19 among frontline health care workers in Amhara Region, Ethiopia: A cross-sectional survey. PLoS One [Internet]. 2021 Apr 1 [cited 2021 Nov 14];16(4):e0251000. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0251000

25. Arakaki T, Hasegawa J, Sekizawa A, Ikeda T, Ishiwata I, Kinoshita K, et al. Clinical characteristics of pregnant women with COVID-19 in Japan: a nationwide questionnaire survey. BMC Pregnancy Childbirth [Internet]. 2021 Dec 1 [cited 2021 Nov 14];21(1):1–8.

Available from: https://bmcpregnancychildbirth.biomedcentral.com/articles/10.1186/s12884-021-04113-9

26. Kai D, Goldstein G-P, Morgunov A, Nangalia V, Rotkirch A. Universal Masking is Urgent in the COVID-19 Pandemic: SEIR and Agent Based Models, Empirical Validation, Policy Recommendations. 2020 Apr 22 [cited 2022 Mar 14]; Available from: http://arxiv.org/abs/2004.13553

27. Ejaz H, Alsrhani A, Zafar A, Javed H, Junaid K, Abdalla AE, et al. COVID-19 and comorbidities: Deleterious impact on infected patients. J Infect Public Health [Internet]. 2020 Dec 1 [cited 2021 Nov 14];13(12):1833. Available from: /pmc/articles/PMC7402107/

28. WHO. Coronavirus disease (COVID-19): situation report, 141 [Internet]. 2020. [cited 2021 Nov 14]. Available from: https://apps.who.int/iris/handle/10665/332390

29. Crovetto F, Crispi F, Llurba E, Figueras F, Dolores Gómez-Roig M, Gratacós E, et al. SEROPREVALENCE AND CLINICAL SPECTRUM OF SARS-CoV-2 INFECTION IN THE FIRST VERSUS THIRD TRIMESTER OF PREGNANCY. medRxiv [Internet]. 2020 Jun 19 [cited 2021 Nov 14];2020.06.17.20134098. Available from: https://www.medrxiv.org/content/10.1101/2020.06.17.20134098v1

30. Lopez M, Hawkins-Villarreal A, Goncé A, Ribera L, Valdes-Bango Curell M, Castillo K, et al. OP03.02: Clinical spectrum of COVID-19 infection throughout gestation. Ultrasound Obstet Gynecol [Internet]. 2021 Oct [cited 2021 Nov 14];58(S1):65–65. Available from: https://onlinelibrary.wiley.com/doi/full/10.1002/uog.23939

31. Eastin C, Eastin T. Clinical Characteristics of Coronavirus Disease 2019 in China: Guan W, Ni Z, Hu Y, et al. N Engl J Med. 2020 Feb 28 [Online ahead of print] DOI: 10.1056/NEJMoa2002032. J Emerg Med [Internet]. 2020 Apr [cited 2021 Nov 14];58(4):711. Available from: /pmc/articles/PMC7266766/

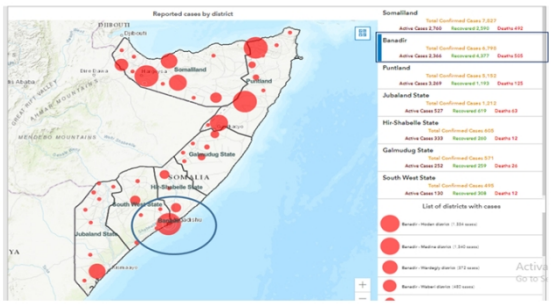
32. Mohamud MFY, Mohamed YG, Ali AM, Adam BA. Loss of Taste and Smell are Common Clinical Characteristics of Patients with COVID-19 in Somalia: A Retrospective Double Centre Study. Infect Drug Resist [Internet]. 2020 [cited 2021 Nov 14];13:2631. Available from: /pmc/articles/PMC7406326/

33. Larsen JR, Martin MR, Martin JD, Kuhn P, Hicks JB. Modeling the Onset of Symptoms of COVID-19. Front Public Heal. 2020 Aug 13;8:473.

34. Arkhipova-Jenkins I, Helfand M, Armstrong C, Gean E, Anderson J, Paynter RA, et al. Antibody Response After SARS-CoV-2 Infection and Implications for Immunity: A Rapid Living Review. Ann Intern Med [Internet]. 2021 Jun 1 [cited 2021 Nov 14];174(6):811–21. Available from: /pmc/articles/PMC8025942/

Figure 1: Map of Somalia showing the COVID-19 cases and death (13/11/2021) with the study area (Benadir region) having the second highest number of confirmed cases (6,798) and the highest mortality (505). https://covid19som-ochasom.hub.arcgis.com/

Figure 2: Overall prevalence of SARS-CoV-2 virus antibodies among pregnant women in Mogadishu, Somalia



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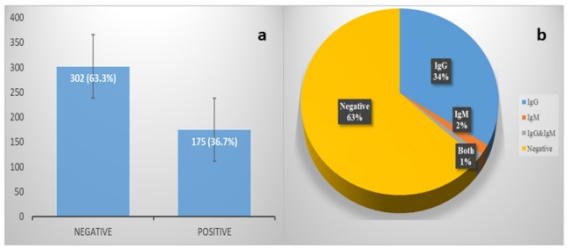

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	4
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	6-12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	-

		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Seroprevalence of SARS-CoV-2 virus antibodies and sociodemographic features of pregnant women in Mogadishu, Somalia: A cross-sectional Survey Study

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Complete List of Authors:	Sh. Nur, Maryan Abdullahi ; SIMAD University, Department of Obstetrics and gynecology, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Dahie, Hassan Abdullahi; SIMAD University, Department of Nursing and Midwifery, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Hasan, Nimca Abdi ; Jazeera university, Department of Obstetrics and gynecology, Jazeera university teaching hospital, Faculty of Medicine, Jazira University, Mogadishu, Somalia. Garba, Bashiru ; Usmanu Danfodiyo University, Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, Usmanu Danfodiyo University Sokoto, Nigeria. Adam, Mohamed Husein Adam; SIMAD University, Department of Public Health, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Mohamoud, Jamal Hassan; SIMAD University, Department of Public Health, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Dirie, Najib Isse; SIMAD University, Urology department, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences
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Seroprevalence of SARS-CoV-2 virus antibodies and sociodemographic features of pregnant women in Mogadishu, Somalia: A cross-sectional Survey Study

Maryan Abdullahi Sh. Nur[1], Hasan Abdullahi Dahie[3], Nimca Abdi Hasan[7], Bashiru Garba[5,6], Mohamed Husein Adam[4], Jamal Hasan Mohamoud[4], Najib Isse Dirie[2]

1. Department of Obstetrics and Gynecology, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
2. Department of Urology, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
3. Department of Nursing and Midwifery, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
4. Department of Public Health, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
5. Institute for Medical Research, SIMAD University, Mogadishu, Somalia.
6. Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, Usmanu Danfodiyo University Sokoto, Nigeria.
7. Department of Obstetrics and Gynecology, Jazeera University Teaching Hospital, Faculty of Medicine, Jazeera University, Mogadishu, Somalia.

***Corresponding author:** Najib Isse **DIRIE**; E-mail: drnajib@simad.edu.so

ABSTRACT

Objective: Recent investigations have revealed that COVID-19 during pregnancy substantially increase the risk of harmful outcomes for mothers and neonates including pre-term death and stillbirth, as well as severe maternal morbidity and mortality. Hence, the urgent need to understand the prevalence rate and level of awareness about COVID-19 (SARS-CoV-2 virus infection) and the practice of preventive measures against the disease among pregnant women in Somalia. This study aims to determine the prevalence of COVID-19 among pregnant women seeking antenatal care in the Benadir region (Mogadishu) of Somalia and to assess their knowledge and preventive practices towards COVID-19.

Setting: A hospital-based cross-sectional study involving two major referral maternity hospitals in Mogadishu, Somalia.

Participants: Pregnant women seeking antenatal services were included in our study.

Methods: A total of 477 blood samples were collected from pregnant women attending the two referral hospitals in Mogadishu and screened for COVID-19. The participants were subjected to questionnaire interviews where their detailed history and practice of prevention against COVID-19 were evaluated.

Results: The results showed that 175 (36.7%) were positive while 302 (63.3%) samples were negative for SARS-CoV-2 virus antibodies. Also, out of the 141 pregnant women who had two children or less, 19.4% were positive for IgG/IgM antibodies. Participants who had close contact with COVID-19 patients were significantly associated for testing positive with a p-value 0.0001. Students, teachers, employed people, and individuals reported COVID-19 like symptoms were all associated with COVID-19 seropositivity outcomes.

Conclusion: Pregnant women, and those with commorbidies should be given special preventive care and health education about COVID-19 transmission.

Strength and limitation of the study:

- A cross-sectional study was used to assess the COVID-19 prevalence among pregnant women.
- Exclusion of vaccinated pregnant women will prevent false-positive results due to vaccine induced antibodies.
- The selected sites are the two major public hospitals providing free maternal and child care services in Mogadishu and neighboring states including mothers from IDP camps.
- Using questionnaires as a tool for data collection may associate with recall bias.
- The RT-PCR is still the gold standard method in detecting active COVID-19 infection.

Keywords: Seroprevalence; COVID-19; Anti-SAR-COV-2 antibodies; Pregnancy; Mogadishu; Somalia.

INTRODUCTION

Since the announcement of the COVID-19 (SARS-CoV-2 virus infection) outbreak as a public health emergency of international concern and its subsequent proclamation as a pandemic in the year 2020, the dramatic loss of human life and the associated public health and socio-economic challenges that ensued has been devastating. As of 1 December, 2021, the number of confirmed COVID-19 cases globally stands at 262,178,403, with 5,215,745 deaths [1]. Interestingly, the African continent has the least cases compared to the Americas, Europe, or Asia, despite its seeming poor public health system. Similarly, the case-fatality ratio for COVID-19 in Africa is lower than the global case-fatality ratio, which also implies that the outcome of the SARS-CoV-2 virus infection has been less severe among African populations [2]. Despite, the low number of confirmed cases in the continent being attributed to the low testing rates, which has continued to undermine the continental response [3]. Nonetheless, other factors that have been reported to contribute to the low incidence and mortality rate in Africa are; cross immunity with malaria, lower population mean age, lower number of individuals with comorbidities like cardiovascular diseases as well as lower pre-COVID-19 era '65yr+ mortality rate' [4,5]. Notwithstanding these apprehensions, there is no evidence that a large number of COVID-19 deaths have been missed;

instead, the low numbers of confirmed cases can be attributed in part to the lessons learned during the handling of several infectious disease outbreaks that have occurred in the continent including Yellow fever, Ebola, HIV, and AIDS [6].

Despite having one of Africa's most fragile health care systems, occasioned by the ongoing conflict and destruction of public health infrastructure, the number of cases in Somalia is relatively low. However, cases have in recent months increased tenfold, and there are indications of community transmission beyond the major cities [7]. The risk of acquiring COVID-19 is known to be higher among the elderly as well as individuals with underlying comorbidities, including moderate to severe asthma, diabetes, cardiovascular diseases, and other respiratory illnesses, including pregnancy which predisposes to severe illness [8–10]. The pandemic has disproportionately impacted vulnerable groups such as persons with disabilities and internally displaced people living in makeshift camps in Somalia. The above has been driven by the non-adherence to the outlined public health measures and has contributed significantly to the increasing number of cases recorded in the country.

Until recently, many studies have shown that pregnant women do not seem to be at a higher risk of getting COVID-19 [11]. In other words, being pregnant does not increase the chances of getting COVID-19 more than non-pregnant persons; however, recent studies have shown that COVID-19 during pregnancy is associated with severe outcomes such as high rate of maternal morbidity and mortality, and neonatal complications [12–14]. There are also emerging evidence that the risk of having stillbirth may be higher among pregnant COVID-19 patients [15]. These pre-neonatal and neonatal period complications are attributed to pregnant women's reduced respiratory capacity, low immunity, and the hemodynamic changes they undergo. The risk of severe maternal outcomes is even higher if they have pulmonary comorbidities, hypertensive disorders, and diabetes mellitus [16]. Moreover, investigations have shown women to be a vulnerable group during the COVID-19 pandemic. This worry is even more among pregnant women who occasionally experience pregnancy and postpartum mental illnesses (depression, anxiety, and postpartum psychosis), resulting in bipolar disorder [17]. These situations are a cause for concern in Somalia, whose women of reproductive age represent 38% of the

household, with a worrying maternal mortality rate of 692 [18]. Also, among the 23,102 cases as of 2/12/2021, 26% (amounting >6006 cases) are female.

The main strategy for each country is to vaccine their general public against COVID-19; the WHO and all governments around the globe are doing their best efforts and advocacy for mass vaccination. To date, a total of 7,772,799,316 vaccine doses have been done according to the data released daily by the WHO. The Ministry of health (MoH) of the federal government of Somalia has been vaccinating the public since 2020 based on vaccines donated by international organizations and some governments. Since the vaccination program started, the MoH was hesitant to vaccinate pregnant women for lack of evidence; however, on 18 November 2021, they released a newsletter stating that MoH recommends vaccinating pregnant women with a single dose J&J COVID-19 vaccine after the first trimester.

This survey was conducted among pregnant women to study if they were exposed to COVID-19 based on the *OnSite* COVID-19 IgG/IgM Rapid Test that detects anti-SARS-CoV-2 IgG and IgM antibodies in serum and plasma. The aim was to estimate the prevalence of diagnosed COVID-19 among pregnant women in Somalia's Benadir region. Also, a questionnaire was administered to consenting participants to determine demographic characteristics and potential risk factors for COVID-19. We also intend to evaluate the presence or otherwise of any association between the participant's sociodemographic features with their respective COVID-19 status.

MATERIAL AND METHODS

Study Design: We present a cross-sectional study aiming to estimate the Seroprevalence of SARS-CoV-2 antibodies among pregnant women attending referral hospitals in Mogadishu, Somalia, from July 31st 2021 to August 31st 2021 (**Figure 1**). Women who indicated their informed consent and had no history of COVID-19 vaccination were included in the survey. Participants who did not consent to participate in the study were excluded.

Study Setting: The selected hospitals are the major two referral hospitals for mother and child in the capital city of Mogadishu. Both hospitals are located on either side of the city and routinely

offer free medical services to the mother and child. One hospital in the south provides services to the most vulnerable in the society, mainly the internally displaced people (IDP) from the regions in the south of Somalia. And the other hospital located in the north of the city covers the city's north districts, including patients from nearby central Somalia regions. The consenting participants were administered a questionnaire covering demographics, obstetrical history, general health status, COVID-19 status, and COVID-19 preventive measures. The questionnaire was prepared using Google form for ease of use, processing, and analyzing the data generated.

Sample size determination

We assumed a 50% prevalence since no study had previously been done to determine the Seroprevalence of COVID-19 antibodies among pregnant women in Somalia.

Therefore, based on the Cochran's formula for sample size calculation ($N = Z^2 \times P\ (1\text{-}P) \div \varepsilon^2$)

Where, Z is 1.96 (constant), e is the desired level of precision (i.e. 5% margin of error at 95% confidence interval), p estimated prevalence (5.7%), and q is 1 – p.

Therefore

$N = Z^2 \times P\ (1\text{-}P) \div \varepsilon^2$

$N = 3.8416 \times 0.5\ (1\text{-}0.5) \div 0.0025$

$N = 384.16$ samples

However, in order to increase our chances of detection, 477 samples were collected.

Serological Testing: Participants were tested with the CTK BIOTECH's *OnSite* COVID-19 IgG/IgM Rapid Test (California, USA) following the instructions given by the manufacturer. The *OnSite* COVID-19 IgG/IgM Rapid Test is suitable for detecting individuals with recent or latent infection to SARS-CoV-2 virus infection, indicating recent or prior infection. The *OnSite* COVID-19 IgG/IgM Rapid Test is one of the most effective test for detecting previous exposure to SARS-CoV-2 virus infection virus with a 97.1% sensitivity and 97.8% specificity.

Four trained doctors, assisted by three junior doctors, and a final year obstetrician-gynecology postgraduate student participated in the blood sample collection and filling of the Google form questionnaires according to inputs from the participants (pregnant women attending antenatal services). Participants were given a detailed explanation of the study purpose and procedure, while the confidentiality of their data was granted.

The study's primary outcome was the seroprevalence of IgG & IgM-specific antibodies in a cohort of pregnant women during the study period. In our analysis, we stratified the population according to the results of the serological study (IgG, IgM, & IgG/IgM positive vs. negative group). Those with positive IgG/IgM were further subdivided depending on the presence or absence of COVID-19 related risky behaviors, obstetrical characteristics, history of chronic illnesses, and COVID-19 symptoms at any time before the serological study using descriptive and inferential analysis.

Statistical Analysis: For the descriptive analysis, the general distribution of all the variables included in this study was assessed by frequency and percentages for categorical variables and means and standard deviations for continuous data using SPSS statistical software version 25. For inferential analysis, we used logistic regression to examine the relationship between predictor variables and the outcome variables.

Patient and Public Involvement: It was not appropriate or possible to involve patients or the public in the design, or conduct, or reporting, or dissemination plans of our research.

Research Ethics Approval: The investigation commenced after Our Institutional Review Board approved all study procedures (SIMAD University Ethics Committee. **ID:** IMRSU/FMHS (FR18) P003).

RESULTS

From July 31st 2021 to August 31st 2021, a total of 477 eligible pregnant women were tested for SARS-COV-2 virus infection specific antibodies. The single-use lateral flow immunoassay test kit is used for detection and differentiation of anti-SARS-CoV-2 virus infection IgG and IgM immunoglobulins where a total of 302 (63.3%) serum samples were found to be negative for SARS-CoV-2 virus infection while 175 (36.7%) turned out to be positive (**Figure 2a**). Similarly,

34% of the circulating antibodies were IgG indicating long-term infection, while IgM circulation was found in only 2% of the women (**Figure 2b**).

The COVID-19-related sociodemographic characteristics analyzed, including age, occupational status, and the number of people in the household, were all found not to be statistically significant ($p>0.05$). However, other demographics studied like marital status, showed that respondents that are married have increased risk of contracting the COVID-19 infection in relation to their counterparts that are not married, and this finding is statistically significant (**Table 1**). Similarly, in terms of the education status, not having formal education was found to be a statistically significant risk factor for contracting COVID-19 with p-value of 0.004. Important to note that, statistical significance in this case does not equate causation, rather, it implies increased risk.

Table 1: Socio-demographic characteristics of pregnant women in Mogadishu, Somalia

Demographics	N	COVID-19 (IgG/IgM)		OR at 95%CI	P value
		Positive (175)	Negative (302)		
Age					
<25 years	213(44.7)	72 (41.1)	141 (46.7)	1.253(0.860-1.826)	0.241
≥25 years	264(55.3)	103 (58.9)	161 (53.3)	Ref.cat	
Marital status					
Married	341 (71.5)	109 (62.3)	232 (76.8)	2.007(1.337-3.012)	0.001*
Unmarried	136 (28.2)	66 (37.7)	70 (23.2)	Ref.cat	
Educational level					
Informal education	267(56.0)	83 (47.4)	184 (60.9)	1.728(1.187-2.518)	0.004*
Formal Education	210(44.0)	92 (52.6)	118 (39.1)	Ref.cat	
Occupation					
Unemployed	359 (75.3)	119 (68.0)	240 (79.5)	1.822(1.193-2.781)	0.005*
Employed	118 (24.7)	56 (32.0)	62 (20.5)	Ref.cat	
No. of household					
≤5	103 (21.6)	32 (18.3)	71 (23.5)	Ref.cat	
>5	374 (78.4)	143 (81.7)	231 (76.5)	0.728(0.457-1.161)	0.182

* Statistically significant at the 0.05 level

According to the obstetrical characteristics of the respondents, 34 (19.4%) of women who reported they had given birth to less than two children were found to have circulating levels of

SARS-CoV-2 antibodies, and this result was statistically significant at p=0.0001. While the other variables (history of abortion and stage of gestation) were not a potential risk factor to acquiring COVID-19 since none of them was found to be significant (**Table 2**).

Table 2: Obstetric characteristics of pregnant women in Mogadishu, Somalia

Characteristic	N	COVID-19 IgG/IgM test		OR 95%CI	P value
		Positive (175)	Negative (302)		
Parity					
0-2	141 (29.6)	34 (19.4)	107 (35.4)	0.439(0.289-0.684)	0.0001*
>2	336 (70.4)	141 (80.6)	195 (64.6)	Ref.cat	
History of abortion					
Yes	105 (22.0)	35 (20.0)	70 (23.2)	0.829(0.525-1.308)	0.420
No	372 (78.0)	56 (22.0)	50 (16.6)	Ref.cat	
Gestational age					
<13 weeks	65 (13.6)	29 (16.6)	36 (11.9)	Ref.cat	0.127
14-26 weeks	92(19.3)	30(17.1)	62 (20.5)	1.665(0.865-3.205)	0.206

* Statistically significant at the 0.05 level

Some of the unhealthy behaviors reported to increase the risk of other respiratory illnesses were also evaluated in this study. Notable among them is the smoking of cigarettes, Shisha, and the local habit of chewing Khat (*Catha edulis*), a stimulant plant frequently chewed among Somalis. Among these, only the smoking of shisha (4.6% positive) was found to pose a risk for contracting COVID-19 infection due to sharing of pipes.

Furthermore, human-to-human transmission of COVID-19 is precipitated by close contact with family members and is usually high when the number of families in a household is considerable. In order to evaluate the association between the number of people in the household with the risk of contracting the infection, participants were asked questions relating to knowledge about their COVID-19 status, familiarity with the basic clinical signs of COVID-19, the possibility of transmission within family members as well as observance of public health preventive measures (**Table 3**).

Table 3: COVID-19 status among pregnant women in Mogadishu, Somalia

Characteristic	N	COVID-19 (IgG/IgM)		OR 95%(CI)	P value
		Positive (175)	Negative (302)		
Were you ever tested for COVID-19?					
Yes	139 (29.1)	67 (38.3)	72 (23.8)	1.982(1.324-2.967)	0.001*
No	338 (70.9)	108 (61.7)	230 (76.2)	Ref.cat	
What was the result?					
Positive	55 (11.6)	34 (19.5)	21 (7.0)	0.283(0.156-0.511)	0.0001*
Negative	96 (20.2)	38 (21.8)	58 (19.2)	0.698(0.436-1.119)	0.135
Not applicable	325 (68.3)	102 (58.6)	223 (73.8)	Ref.cat	
Have you ever had COVID-19?					
Yes	102 (21.4)	60 (34.3)	42 (13.9)	0.639(0.385-1.060)	0.083
No	222 (46.5)	42 (24.0)	180 (59.6)	3.911(2.464-6.207)	0.0001*
Not sure	153 (32.1)	73 (41.7)	80 (26.5)	Ref.cat	
Did you have COVID-19 symptoms?					
Yes	193 (40.5)	126 (72.0)	67 (22.2)	9.019(5.883-13.827)	0.0001*
No	284 (59.5)	49 (28.0)	235 (77.8)	Ref.cat	
Did you have fever?					
Yes	212 (44.4)	130 (74.3)	82 (27.2)	7.751(5.076-11.836)	0.0001*
No	265 (55.6)	45 (25.7)	220 (72.8)	Ref.cat	
Did you have cough?					
Yes	216 (45.3)	138 (78.9)	78 (25.8)	10.711(6.864-16.715)	0.0001*
No	261(54.7)	37 (21.1)	224 (74.2)	Ref.cat	
Did you lose your smell?					
Yes	180 (37.7)	127 (72.6)	53 (17.5)	12.430(7.964-19.401)	0.0001*
No	297 (62.3)	48 (27.4)	249 (82.5)	Ref.cat	
Did you lose your taste?					
Yes	166 (34.8)	118 (67.4)	48 (15.9)	10.955(7.043-17.038)	0.0001*
No	311 (65.2)	57 (32.6)	254 (84.1)	Ref.cat	
Did you have stomach upset?					
Yes	135 (28.3)	103 (58.9)	32 (10.6)	12.070(7.512-19.395)	0.0001*
No	342 (71.7)	72 (41.1)	270 (89.4)	Ref.cat	
Did you have shortness of breath?					
Yes	170 (35.6)	122 (69.7)	48 (15.9)	12.181(7.796-19.031)	0.0001*
No	307 (64.4)	53 (30.3)	254 (84.1)	Ref.cat	
When was the time you had the symptoms					
<3 months	87 (18.2)	48 (27.4)	39 (12.9)	0.075(0.039-0.0146)	0.0001*
3-6 months	35 (7.3)	22 (12.6)	13 (4.3)	0.055(0.023-0.129)	0.0001*
>6 months	166 (34.8)	89 (50.9)	77 (25.5)	0.080(0.044-0.145)	0.0001*
Not applicable	189 (39.6)	16 (9.1)	173 (57.3)	Ref.cat	
Close contact with someone having COVID-19					
Yes	158 (33.1)	110 (62.9)	48 (15.9)	0.218(0.117-0.407)	0.0001*
No	256 (53.7)	44 (25.1)	212 (70.2)	2.409(1.201-4.462)	0.005*
Not sure	63 (13.2)	21 (12.0)	42 (13.9)	Ref.cat	
Did any household contact colleagues or close friend had COVID-19?					
Yes	195 (40.9)	126 (72.0)	69 (22.8)	8.683(5.674-13.288)	0.0001*
No	282 (59.1)	49 (28.0)	233 (77.2)	Ref.cat	
Was anyone of your close contacts hospitalized for COVID-19					
Yes	169 (35.4)	115 (65.7)	54 (17.9)	8.802(5.732-13.518)	0.0001*
No	308 (64.6)	60 (34.3)	248 (82.1)	Ref.cat	
Did anyone of your close contacts die of COVID-19?					
Yes	182 (38.2)	124 (70.9)	58 (19.2)	10.229(6.628-15.785)	0.0001*
No	295 (61.8)	51 (29.1)	244 (80.8)	Ref.cat	

* Statistically significant at the 0.05 level

A total of 193 pregnant women reported having had COVID-19 infection, out of which 126 (72%) presented clinical signs indicative of the disease while asymptomatic were 67(22.2%). The most common symptom presented by the infected women were cough (78.9%), fever (74.3%), shortness of breath (69.7%), loss of smell (72.6%), and stomach upset (58.9%). The timing of symptoms appearing differed significantly between gestations, first trimester (27.4%), second trimester (12.6%), and third trimester (50.9%). Close contact with a family member of someone who had COVID-19 was also a significant finding for testing positive with a p-value =0.004. We also observed that the number of close contacts the respondents knew who had A total of 193 pregnant women reported having had COVID-19 infection out of which 126 (72%) presented clinical signs indicative of the disease while asymptomatic were 67(22.2%). The most common symptom presented by the infected women were cough (78.9%), fever (74.3%), shortness of breath (69.7%), loss of smell (72.6%), and stomach upset (58.9%). The timing of symptoms appearing differed significantly between gestations, first trimester (27.4%), second trimester (12.6%), and third trimester (50.9%). Close contact with a family member of someone who had COVID-19 was also a significant finding for testing positive with a p-value =0.004. We also observed that the number of close contacts the respondents knew whom COVID-19 had was more likely hospitalized (65.7%) or died of the infection (70.9%).

Observing social and physical distances was statistically significant compared with not observing this essential preventive measure (**Table 4**). The result revealed that 41.7% of the respondents admitted to observing distancing among others (168), which is lower than the number of respondents that admitted to not practicing distancing (308), and this was found to be statistically significant ($p<0.05$). Except for the use of face mask, which showed the number of those using it (268) was higher than those not using (209), the adherence to other preventive measures was poor, particularly frequent hand washing, which showed 53.1% not practicing handwashing compared to 46.9% that claimed they regularly wash their hands. Importantly, this finding was not statistically significant; however, the odds are greater than 1, implying that not adhering to these preventive measures could increase the chances of contracting COVID-19.

Table 4: Preventive measures observed by the of pregnant women in Mogadishu, Somalia

Characteristic	N	COVID-19 (IgG/IgM)		OR 95%CI	P value
		Positive (175)	Negative (302)		
Do you regularly wear face mask?					
Yes	268 (56.2)	108 (61.7)	160 (53.0)	Ref.cat	
No	209 (43.8)	67 (38.3)	142 (47.0)	1.431(0.979-2.091)	0.064
If "yes", what types of mask do you wear?					
N95	43 (9.0)	18 (10.3)	25 (8.3)	Ref.cat	
Surgical face mask	79 (16.6)	23 (13.1)	56 (18.5)	1.753(0.807-3.810)	0.156
Others	163 (34.2)	70 (40.0)	93 (30.8)	0.957(0.484-1.889)	0.898
Not applicable	192 (40.3)	64 (36.6)	128 (42.4)	1.440(0.732-2.831)	0.290
Do you regularly wash your hands					
Yes	205 (43.0)	82 (46.9)	123 (40.7)	Ref.cat	
No	272 (57.0)	93 (53.1)	179 (59.3)	1.283(0.882-1.868)	0.193
Do you keep your distance from others					
Yes	168 (35.2)	73 (41.7)	95 (31.5)	Ref.cat	
No	309 (64.8)	102 (58.3)	207 (68.5)	1.643(0.903-2.988)	0.104
Do you avoid handshaking?					
Yes	164 (34.4)	66 (37.7)	98 (32.5)	Ref.cat	
No	313 (65.6)	109 (62.3)	204 (67.5)	0.858 (0.484-1.520)	0.599

* Statistically significant at the 0.05 level

Comorbidities of pregnant women with confirmed SARS-CoV-2 virus infection are shown in **Table 5**. There was a significant difference in mean between the COVID-19-positive pregnant women and COVID-19 negative pregnant women across all the comorbidities inquired (diabetes, hypertension, cardiovascular disease, and asthma) with a p-value of 0.001. The odds ratio was also greater than 1, which means greater odds of association with having any chronic illness and the chances of becoming infected with COVID-19.

Table 5: Comorbidities of pregnant women with conformed SARS-CoV-2 virus infection

Characteristic	N	COVID-19 (IgG/IgM)		OR 95%CI	P value
		Positive (175)	Negative (302)		
Do you have diabetes?					
Yes	94(19.7)	50 (28.6)	44 (14.6)	2.345(1.484-3.708)	0.0001*
No	383 (80.3)	125(71.4)	258 (85.4)	Ref.cat	
Do you have hypertension?					
Yes	124 (26.0)	67 (38.3)	57(18.9)	2.667(1.753-4.056)	0.0001*
No	353 (74.0)	108 (61.7)	245 (81.1)	Ref.cat	
Do you have cardiac disease?					
Yes	85 (17.8)	46 (26.3)	39 (12.9)	2.811(1.721-4.590)	0.0001*
No	392 (82.2)	129 (73.7)	263 (87.1)	Ref.cat	
Do you have asthma?					
Yes	85 (17.8)	46 (26.3)	39 (12.9)	2.405(1.494-3.870)	0.0001*
No	392 (82.2)	129 (73.7)	263 (87.1)	Ref.cat	
Do you have family history of hypertension?					
Yes	137 (28.7)	63 (36.0)	74 (24.5)	1.733(1.156-2.598)	0.008*
No	340 (71.3)	112 (64.0)	228 (75.5)	Ref.cat	
Do you have family history of diabetes?					
Yes	148 (31.0)	72 (41.1)	76 (25.2)	2.079(1.397-3.094)	0.0001*
No	329 (69.0)	103 (58.9)	226 (74.8)	Ref.cat	
Do you have family history of cardiac disease?					
Yes	155 (32.5)	76 (43.4)	79 (26.2)	2.167(1.461-3.213)	0.0001*
No	322 (67.5)	99 (56.6)	223 (73.8)	Ref.cat	
Do you have family history of asthma?					
Yes	137 (28.7)	64 (36.6)	73 (24.2)	1.809(1.206-2.712)	0.004*
No	340 (71.3)	111 (63.4)	229 (75.8)	Ref.cat	
Do you have family history of obesity?					
Yes	193 (40.5)	89 (50.9)	104 (34.4)	1.970(1.348-2.880)	0.0001*
No	284 (59.5)	86 (49.1)	198 (65.6)	Ref.cat	
Do you take regular medications?					
Yes	137 (28.7)	66 (37.7)	71 (23.5)	0.494(0.328-0.744)	0.001*
Herbal medication	19 (4.0)	8 (4.6)	11 (3.6)	0.631(0.246-1.617)	0.338
No	321 (67.3)	101 (57.7)	220 (72.8)	Ref.cat	

* Statistically significant at <0.05

DISCUSSION

The cross-sectional approach used was because of the urgent need to understand the status of the disease among pregnant women due to their suppressed immune status, especially given the speed at which the disease was developing. This study investigated the prevalence, knowledge, and preventive practices towards COVID-19 among pregnant women seeking antenatal services in two of the major public hospitals in Mogadishu, within the Benadir region of Somalia. The study coincided with the third wave of the COVID-19 outbreak in Somalia around early July 2021. During this period, a total of 477 pregnant women were screened for confirmation of COVID-19 using the CTK BIOTECH's *OnSite* COVID-19 IgG/IgM Rapid Test kit which is capable of identifying SARS-CoV-2 antibodies with 97.1% and 97.8% sensitivity and specificity respectively [19]. To date, the most reliable method of detecting SARS-CoV-2 virus infection is RT-PCR [20,21]. Nonetheless, the *OnSite* COVID-19 IgG/IgM Rapid Test can identify individuals with circulating antibodies against the SARS-CoV-2 virus infection either as a result of recent or prior infection [19]. In this study, the predominant immunoglobulin among the COVID-19 positive pregnant women was IgG with 34% circulation followed by IgM with 2%. During the acute phase of COVID-19 infection, IgM blood levels against SARS-CoV-2 virus infection rise rapidly and peak after 2-3 weeks of contracting the virus, followed by SARS-CoV-2 virus infection specific IgG antibodies appearing and persist in the circulation for months. Because of the inability of the test kit (*OnSite* COVID-19 IgG/IgM) to distinguish COVID-19 vaccine-induced antibodies and antibodies as a result of SARS-CoV-2 infection, we decide to exclude all pregnant women that have received single or multiple shots of the COVID-19 vaccine. This ensures that only pregnant women with infection (acute or chronic) are diagnosed as positive [22]. Based on this, the majority of the COVID-19 positive pregnant women sampled were found to have a chronic long-term infection (predominance of IgG). This outcome is similar to the previous report where titers of IgG targeting N-protein of SARS-CoV2 was recommended as a prognostic factor in understanding the clinical course of COVID-19 and that it should be measured in all patients with SARS-CoV2 infection [23].

The overall prevalence of SARS-CoV-2 virus infection among pregnant women was 36.7%, with 3% of the total having an active infection, but none needed critical care. Even though earlier studies have reported a prevalence of 61% among healthcare workers, the 36.7% recorded in this

study is distressing, this is because the 61% we referred to was from a study conducted among healthcare workers in Somalia [24]. It is not a surprise to see a high number of cases among this category of people because they constitute the frontline workers at the most significant risk of contracting the disease [25]. This figure (36.7%) is considerably high when studies were done in Japan and New York, which found a seroprevalence of 0.03% and 16.4%, respectively [16,26].

Concerning the adherence to the outlined preventive measures, including avoiding crowd, frequent washing of hands with detergents or disinfectants, and the use of face coverings, we observed a worrying trend where the majority of the respondents admitted to not practicing these aforementioned public health guidelines with an increased odd of contracting the disease as a result (OR>1). This undesirable habit of not adhering to the recommended preventive practice may give further credence to the high number of positive cases recorded in this study. We understand that observing these set-out regulations will be challenging and complex because of some Somali culture and traditions of congregating, sharing hugs, and shaking hands. Nonetheless, considering the vulnerabilities of pregnant women, there is an urgent need to ensure compliance with these COVID-19 requirements; otherwise, things may only worsen for pregnant women in Somalia. It is important to point out that, based on the results of this study, no difference in terms of increased risk was observed between wearing mask and not wearing. This may not however be surprising because public mask wearing is most effective at reducing spread of the virus when the recommended mask is worn properly with high compliance [27]. Additionally, because wearing masks has been reported to bring down the overall risk of spreading COVID-19, people have become careless and less likely to abide by standard measures and more willing to take other risks, such as decreasing the physical distance between them and others. Furthermore, despite the results showing no risk of contracting infection regardless of whether a mask is worn or not, in contrast to the popular report on face covering, it is likely that this discrepancy may be because of the careless attitude among people wearing mask for the mere believe that the mask will protect them. Interestingly, only 25.6% of those that claimed they wear mask reported they used the recommended mask (N95-9% and surgical mask 16.6%). The remaining reported wearing masks made of simple clothes while others considered Islamic face veil (Niqab) to be enough face mask for COVID-19 prevention.

Additional vital findings in this study are the relationship of COVID-19 positive status and comorbidity. Since the first outbreak, we have come to realize that SARS-CoV-2 infects people of all age groups; however, elderly people (above 60 years), as well as individuals with comorbidities such as chronic respiratory disease (asthma patients), diabetes and cardiovascular diseases, are at a greater risk of developing infection with severe outcomes [28,29]. Although most of the respondents admitted to not having any of the chronic disease conditions asked, viz hypertension, diabetes, asthma, cardiovascular disease, and obesity (74-82%). Nevertheless, many pregnant women (17.8-28.7%) indicated they have one or more of these comorbidities, as mentioned earlier, which will increase the risk for them and their unborn children.

Other potential risk factors evaluated in this study, such as parity, history of abortion, stage of gestation, and some unhealthy behaviors like smoking, revealed no significant relationship concerning increasing chances of contracting COVID-19 among pregnant women, with an odds ratio of 0.4 to 0.8. However, the risk for contracting the disease for smokers of Shisha was very high with an odds ratio of 3.569, and this finding was statistically significant (p=0.04). Like other studies, none of the different trimesters of pregnancy was associated with a high risk of getting the infection. A study done in Spain found that Seroprevalence was similar between women in the first trimester of pregnancy and women in the third trimester, suggesting a similar risk of infection. However, the proportion of women with symptoms and those requiring hospitalization was higher in the third-trimester group than in the first-trimester group [30,31]. On the other hand, available data have already indicated that smoking doubles the risk of having severe COVID-19 [32]. Lung damage from COVID-19 resembles the damage of smoke from cigarettes and other tobacco products that introduce particulate matter from the environment into the lungs. Notably, the mouthpiece and the hose in the shisha can serve as a means of transmission of the COVID-19 virus, which can also spread through shisha sharing.

Participants who reported COVID-like symptoms were more likely to turn positive when tested for COVID-19. Though some reported no history of COVID-19 infection, this wave arrived simultaneously with the already expected seasonal flue. The order and frequency of symptoms were almost the same with a study done in Mogadishu in which the most typical symptom reported was cough (>75%), followed by fever (>71%) and loss of taste and smell [33]. Other

studies show that fever and cough were the most typical symptoms reported, followed by stomach upset [34]. We also observed that pregnant women who reported having had a previous infection with COVID-19 were more likely to test positive. Though COVID-19 specific immunity may disappear in three months, one may believe that since they were infected in previous waves, they still sustain immunity and do not practice preventive measures [35].

In conclusion, the COVID-19 high prevalence observed in this study is disturbing considering how vulnerable pregnant women can be, especially in Somalia, where the healthcare services face serious challenges. The poor attitude in observing preventive measures against COVID-19 among pregnant women also warrants serious attention towards raising awareness among midwives and health care workers who are in close contact with women delivering babies to reduce infection transmission and ensure prevention and control of the virus.

Author Contribution: Najib Isse Dirie, and Maryan Abdullahi Sh. Nur conceived the study and drafted the original protocol. Najib Isse Dirie, Hasan Abdullahi Dahie, Nimca Abdi Hasan, Mohamed Husein Adam, and Bashiru Garba, contributed to developing the survey questionnaires. Hasan Abdullahi Dahie, Jamal Hasan Mohamoud, and Bashiru Garba played a major role in the statistical analyses. All the authors participated in, read and approved the final manuscript.

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References

1. Somalia: WHO Coronavirus Disease (COVID-19) Dashboard With Vaccination Data | WHO Coronavirus (COVID-19) Dashboard With Vaccination Data [Internet]. [cited 2021 May 25]. Available from: https://covid19.who.int/region/emro/country/so
2. Partnership for Evidence-Based Response to COVID-19 (PERC) - Prevent Epidemics [Internet]. [cited 2021 Nov 13]. Available from: https://preventepidemics.org/covid19/perc/
3. Chitungo I, Dzobo M, Hlongwa M, Dzinamarira T. COVID-19: Unpacking the low number of cases in Africa. Public Heal Pract [Internet]. 2020 Nov [cited 2021 Nov 13];1:100038. Available from: /pmc/articles/PMC7485446/
4. Osei SA, Biney RP, Anning AS, Nortey LN, Ghartey-Kwansah G. Low incidence of COVID-19 case severity and mortality in Africa; Could malaria co-infection provide the missing link? BMC Infect Dis [Internet]. 2022 Dec 1 [cited 2022 Mar 14];22(1):1–11. Available from: https://bmcinfectdis.biomedcentral.com/articles/10.1186/s12879-022-07064-4
5. Lawal Y. Africa's low COVID-19 mortality rate: A paradox? Int J Infect Dis. 2021 Jan 1;102:118–22.
6. Nkengasong J. Let Africa into the market for COVID-19 diagnostics. Nature. 2020 Apr 30;580(7805):565–565.
7. COVID-19 in Somalia: A Public Health Emergency in an Electoral Minefield | Crisis Group [Internet]. [cited 2021 Nov 13]. Available from: https://www.crisisgroup.org/africa/horn-africa/somalia/b155-covid-19-somalia-public-health-emergency-electoral-minefield
8. Sanyaolu A, Okorie C, Marinkovic A, Patidar R, Younis K, Desai P, et al. Comorbidity and its Impact on Patients with COVID-19. Sn Compr Clin Med [Internet]. 2020 Aug [cited 2021 Nov 13];2(8):1. Available from: /pmc/articles/PMC7314621/
9. Garba B, Zakaria Z, Salihu MD, Bande F, Saidu B, Bala JA. Breaking the cycle of the COVID-19 transmission: A challenge for Nigeria. J Glob Health. 2020;10(2).
10. Adam MH, Mohamoud JH, Mohamood AS, Mohamed AA, Garba B, Dirie NI. Seroprevalence of Anti-SARS-CoV-2 Antibodies in Benadir Region, Somalia. Vaccines [Internet]. 2022 Jan 30 [cited 2022 Mar 1];10(2):220. Available from:

/pmc/articles/PMC8877673/

11. Wang CL, Liu YY, Wu CH, Wang CY, Wang CH, Long CY. Impact of COVID-19 on Pregnancy. Int J Med Sci [Internet]. 2021 [cited 2022 Mar 14];18(3):763. Available from: /pmc/articles/PMC7797535/

12. Ames JL, Ferrara A, Avalos LA, Badon SE, Greenberg MB, Hedderson MM, et al. COVID-19 prevalence, symptoms, and sociodemographic disparities in infection among insured pregnant women in Northern California. PLoS One [Internet]. 2021 Sep 1 [cited 2021 Nov 13];16(9):e0256891. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0256891

13. Villar J, Ariff S, Gunier RB, Thiruvengadam R, Rauch S, Kholin A, et al. Maternal and Neonatal Morbidity and Mortality Among Pregnant Women With and Without COVID-19 Infection: The INTERCOVID Multinational Cohort Study. JAMA Pediatr [Internet]. 2021 Aug 1 [cited 2022 Mar 14];175(8):817–26. Available from: https://jamanetwork.com/journals/jamapediatrics/fullarticle/2779182

14. Iacobucci G. Covid-19: Severe infection in pregnancy significantly increases risks, study shows. BMJ [Internet]. 2022 Feb 24 [cited 2022 Mar 14];376:o480. Available from: https://www.bmj.com/content/376/bmj.o480

15. Khalil A, Von Dadelszen P, Draycott T, Ugwumadu A, O'Brien P, Magee L. Change in the Incidence of Stillbirth and Preterm Delivery During the COVID-19 Pandemic. JAMA [Internet]. 2020 Aug 18 [cited 2021 Nov 13];324(7):705. Available from: /pmc/articles/PMC7435343/

16. NM M, A R, Ld W, SM D, W L, E I, et al. Seroprevalence of SARS-CoV-2 during pregnancy and associated outcomes: results from an ongoing prospective cohort study, New York City. 2021 Feb 3 [cited 2021 Nov 13]; Available from: https://europepmc.org/article/PPR/PPR277509

17. Esteban-Gonzalo S, Caballero-Galilea M, González-Pascual JL, Álvaro-Navidad M, Esteban-Gonzalo L. Anxiety and Worries among Pregnant Women during the COVID-19 Pandemic: A Multilevel Analysis. Int J Environ Res Public Health [Internet]. 2021 Jul 1 [cited 2021 Nov 13];18(13). Available from: /pmc/articles/PMC8297358/

18. Ahmed MAM, Fodjo JNS, Gele AA, Farah AA, Osman S, Guled IA, et al. COVID-19 in Somalia: Adherence to Preventive Measures and Evolution of the Disease Burden. Pathog 2020, Vol 9, Page 735 [Internet]. 2020 Sep 6 [cited 2021 Nov 13];9(9):735. Available from: https://www.mdpi.com/2076-0817/9/9/735/htm

19. Lagerqvist N, Maleki KT, Verner-Carlsson J, Olausson M, Dillner J, Wigren Byström J, et al. Evaluation of 11 SARS-CoV-2 antibody tests by using samples from patients with defined IgG antibody titers. Sci Reports 2021 111 [Internet]. 2021 Apr 7 [cited 2021 Nov 14];11(1):1–8. Available from: https://www.nature.com/articles/s41598-021-87289-6

20. Kevadiya BD, Machhi J, Herskovitz J, Oleynikov MD, Blomberg WR, Bajwa N, et al. Diagnostics for SARS-CoV-2 infections. Nat Mater 2021 205 [Internet]. 2021 Feb 15 [cited 2021 Nov 14];20(5):593–605. Available from:

https://www.nature.com/articles/s41563-020-00906-z

21. Liu R, Han H, Liu F, Lv Z, Wu K, Liu Y, et al. Positive rate of RT-PCR detection of SARS-CoV-2 infection in 4880 cases from one hospital in Wuhan, China, from Jan to Feb 2020. Clin Chim Acta. 2020 Jun 1;505:172–5.

22. Mouliou DS, Gourgoulianis KI. False-positive and false-negative COVID-19 cases: respiratory prevention and management strategies, vaccination, and further perspectives. Expert Rev Respir Med [Internet]. 2021 [cited 2022 Apr 30];15(8):1. Available from: /pmc/articles/PMC8074645/

23. Batra M, Tian R, Zhang C, Clarence E, Sacher CS, Miranda JN, et al. Role of IgG against N-protein of SARS-CoV2 in COVID19 clinical outcomes. Sci Reports 2021 111 [Internet]. 2021 Feb 10 [cited 2021 Nov 14];11(1):1–9. Available from: https://www.nature.com/articles/s41598-021-83108-0

24. Abdi A, Ahmed AY, Abdulmunim M, Karanja MJ, Solomon A, Muhammad F, et al. Preliminary findings of COVID-19 infection in health workers in Somalia: A reason for concern. Int J Infect Dis [Internet]. 2021 Mar 1 [cited 2021 Nov 14];104:734. Available from: /pmc/articles/PMC7872860/

25. Atnafie SA, Anteneh DA, Yimenu DK, Kifle ZD. Assessment of exposure risks to COVID-19 among frontline health care workers in Amhara Region, Ethiopia: A cross-sectional survey. PLoS One [Internet]. 2021 Apr 1 [cited 2021 Nov 14];16(4):e0251000. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0251000

26. Arakaki T, Hasegawa J, Sekizawa A, Ikeda T, Ishiwata I, Kinoshita K, et al. Clinical characteristics of pregnant women with COVID-19 in Japan: a nationwide questionnaire survey. BMC Pregnancy Childbirth [Internet]. 2021 Dec 1 [cited 2021 Nov 14];21(1):1–8. Available from: https://bmcpregnancychildbirth.biomedcentral.com/articles/10.1186/s12884-021-04113-9

27. Kai D, Goldstein G-P, Morgunov A, Nangalia V, Rotkirch A. Universal Masking is Urgent in the COVID-19 Pandemic: SEIR and Agent Based Models, Empirical Validation, Policy Recommendations. 2020 Apr 22 [cited 2022 Mar 14]; Available from: http://arxiv.org/abs/2004.13553

28. Ejaz H, Alsrhani A, Zafar A, Javed H, Junaid K, Abdalla AE, et al. COVID-19 and comorbidities: Deleterious impact on infected patients. J Infect Public Health [Internet]. 2020 Dec 1 [cited 2021 Nov 14];13(12):1833. Available from: /pmc/articles/PMC7402107/

29. WHO. Coronavirus disease (COVID-19): situation report, 141 [Internet]. 2020. [cited 2021 Nov 14]. Available from: https://apps.who.int/iris/handle/10665/332390

30. Crovetto F, Crispi F, Llurba E, Figueras F, Dolores Gómez-Roig M, Gratacós E, et al. SEROPREVALENCE AND CLINICAL SPECTRUM OF SARS-CoV-2 INFECTION IN THE FIRST VERSUS THIRD TRIMESTER OF PREGNANCY. medRxiv [Internet]. 2020 Jun 19 [cited 2021 Nov 14];2020.06.17.20134098. Available from:

https://www.medrxiv.org/content/10.1101/2020.06.17.20134098v1

31. Lopez M, Hawkins-Villarreal A, Goncé A, Ribera L, Valdes-Bango Curell M, Castillo K, et al. OP03.02: Clinical spectrum of COVID-19 infection throughout gestation. Ultrasound Obstet Gynecol [Internet]. 2021 Oct [cited 2021 Nov 14];58(S1):65–65. Available from: https://onlinelibrary.wiley.com/doi/full/10.1002/uog.23939

32. Eastin C, Eastin T. Clinical Characteristics of Coronavirus Disease 2019 in China: Guan W, Ni Z, Hu Y, et al. N Engl J Med. 2020 Feb 28 [Online ahead of print] DOI: 10.1056/NEJMoa2002032. J Emerg Med [Internet]. 2020 Apr [cited 2021 Nov 14];58(4):711. Available from: /pmc/articles/PMC7266766/

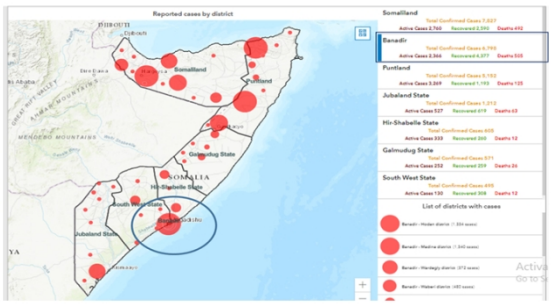
33. Mohamud MFY, Mohamed YG, Ali AM, Adam BA. Loss of Taste and Smell are Common Clinical Characteristics of Patients with COVID-19 in Somalia: A Retrospective Double Centre Study. Infect Drug Resist [Internet]. 2020 [cited 2021 Nov 14];13:2631. Available from: /pmc/articles/PMC7406326/

34. Larsen JR, Martin MR, Martin JD, Kuhn P, Hicks JB. Modeling the Onset of Symptoms of COVID-19. Front Public Heal. 2020 Aug 13;8:473.

35. Arkhipova-Jenkins I, Helfand M, Armstrong C, Gean E, Anderson J, Paynter RA, et al. Antibody Response After SARS-CoV-2 Infection and Implications for Immunity: A Rapid Living Review. Ann Intern Med [Internet]. 2021 Jun 1 [cited 2021 Nov 14];174(6):811–21. Available from: /pmc/articles/PMC8025942/

Figure 1: Map of Somalia showing the COVID-19 cases and death (13/11/2021) with the study area (Benadir region) having the second highest number of confirmed cases (6,798) and the highest mortality (505). https://covid19som-ochasom.hub.arcgis.com/

Figure 2: Overall prevalence of SARS-CoV-2 virus antibodies among pregnant women in Mogadishu, Somalia



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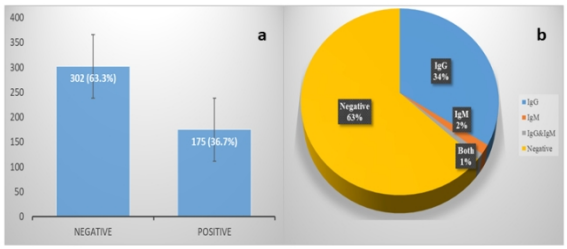

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	4
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	6-12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	-

		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Seroprevalence of SARS-CoV-2 virus antibodies and sociodemographic features of pregnant women in Mogadishu, Somalia: A cross-sectional Survey Study

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Complete List of Authors:	Sh. Nur, Maryan Abdullahi ; SIMAD University, Department of Obstetrics and gynecology, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Dahie, Hassan Abdullahi; SIMAD University, Department of Nursing and Midwifery, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Hasan, Nimca Abdi ; Jazeera university, Department of Obstetrics and gynecology, Jazeera university teaching hospital, Faculty of Medicine, Jazira University, Mogadishu, Somalia. Garba, Bashiru ; Usmanu Danfodiyo University, Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, Usmanu Danfodiyo University Sokoto, Nigeria. Adam, Mohamed Husein Adam; SIMAD University, Department of Public Health, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Mohamoud, Jamal Hassan; SIMAD University, Department of Public Health, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia. Dirie, Najib Isse; SIMAD University, Urology department, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences
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Seroprevalence of SARS-CoV-2 virus antibodies and sociodemographic features of pregnant women in Mogadishu, Somalia: A cross-sectional Survey Study

Maryan Abdullahi Sh. Nur[1], Hassan Abdullahi Dahie[3], Nimca Abdi Hasan[7], Bashiru Garba[5,6], Mohamed Husein Adam[4], Jamal Hassan Mohamoud[4], Najib Isse Dirie[2]

1. Department of Obstetrics and Gynecology, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
2. Department of Urology, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
3. Department of Nursing and Midwifery, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
4. Department of Public Health, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia.
5. Institute for Medical Research, SIMAD University, Mogadishu, Somalia.
6. Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, Usmanu Danfodiyo University Sokoto, Nigeria.
7. Department of Obstetrics and Gynecology, Jazeera University Teaching Hospital, Faculty of Medicine, Jazeera University, Mogadishu, Somalia.

***Corresponding author:** Najib Isse **DIRIE**; E-mail: drnajib@simad.edu.so

ABSTRACT

Objective: Recent investigations have revealed that COVID-19 during pregnancy substantially increase the risk of harmful outcomes for mothers and neonates including pre-term death and stillbirth, as well as severe maternal morbidity and mortality. Hence, the urgent need to understand the prevalence rate and level of awareness about COVID-19 (SARS-CoV-2 virus infection) and the practice of preventive measures against the disease among pregnant women in Somalia. This study aims to determine the prevalence of COVID-19 among pregnant women seeking antenatal care in the Benadir region (Mogadishu) of Somalia and to assess their knowledge and preventive practices towards COVID-19.

Setting: A hospital-based cross-sectional study involving two major referral maternity hospitals in Mogadishu, Somalia.

Participants: Pregnant women seeking antenatal services were included in our study.

Methods: A total of 477 blood samples were collected from pregnant women attending the two referral hospitals in Mogadishu and screened for COVID-19. The participants were subjected to questionnaire interviews where their detailed history and practice of prevention against COVID-19 were evaluated.

Results: The results showed that 175 (36.7%) were positive while 302 (63.3%) samples were negative for SARS-CoV-2 virus antibodies. Also, out of the 141 pregnant women who had two children or less, 19.4% were positive for IgG/IgM antibodies. Participants who had close contact with COVID-19 patients were significantly associated for testing positive with a p-value 0.0001. Students, teachers, employed people, and individuals reported COVID-19 like symptoms were all associated with COVID-19 seropositivity outcomes.

Conclusion: Pregnant women, and those with commorbidies should be given special preventive care and health education about COVID-19 transmission.

Strength and limitation of the study:

- A cross-sectional study was used to assess the COVID-19 prevalence among pregnant women.
- Exclusion of vaccinated pregnant women will prevent false-positive results due to vaccine induced antibodies.
- The selected sites are the two major public hospitals providing free maternal and child care services in Mogadishu and neighboring states including mothers from IDP camps.
- Using questionnaires as a tool for data collection may associate with recall bias.
- The RT-PCR is still the gold standard method in detecting active COVID-19 infection.

Keywords: Seroprevalence; COVID-19; Anti-SAR-COV-2 antibodies; Pregnancy; Mogadishu; Somalia.

INTRODUCTION

Since the announcement of the COVID-19 (SARS-CoV-2 virus infection) outbreak as a public health emergency of international concern and its subsequent proclamation as a pandemic in the year 2020, the dramatic loss of human life and the associated public health and socio-economic challenges that ensued has been devastating. As of 1 December, 2021, the number of confirmed COVID-19 cases globally stands at 262,178,403, with 5,215,745 deaths [1]. Interestingly, the African continent has the least cases compared to the Americas, Europe, or Asia, despite its seeming poor public health system. Similarly, the case-fatality ratio for COVID-19 in Africa is lower than the global case-fatality ratio, which also implies that the outcome of the SARS-CoV-2 virus infection has been less severe among African populations [2]. Despite, the low number of confirmed cases in the continent being attributed to the low testing rates, which has continued to undermine the continental response [3]. Nonetheless, other factors that have been reported to contribute to the low incidence and mortality rate in Africa are; cross immunity with malaria, lower population mean age, lower number of individuals with comorbidities like cardiovascular diseases as well as lower pre-COVID-19 era '65yr+ mortality rate' [4,5]. Notwithstanding these apprehensions, there is no evidence that a large number of COVID-19 deaths have been missed;

instead, the low numbers of confirmed cases can be attributed in part to the lessons learned during the handling of several infectious disease outbreaks that have occurred in the continent including Yellow fever, Ebola, HIV, and AIDS [6].

Despite having one of Africa's most fragile health care systems, occasioned by the ongoing conflict and destruction of public health infrastructure, the number of cases in Somalia is relatively low. However, cases have in recent months increased tenfold, and there are indications of community transmission beyond the major cities [7]. The risk of acquiring COVID-19 is known to be higher among the elderly as well as individuals with underlying comorbidities, including moderate to severe asthma, diabetes, cardiovascular diseases, and other respiratory illnesses, including pregnancy which predisposes to severe illness [8–10]. The pandemic has disproportionately impacted vulnerable groups such as persons with disabilities and internally displaced people living in makeshift camps in Somalia. The above has been driven by the non-adherence to the outlined public health measures and has contributed significantly to the increasing number of cases recorded in the country.

Until recently, many studies have shown that pregnant women do not seem to be at a higher risk of getting COVID-19 [11]. In other words, being pregnant does not increase the chances of getting COVID-19 more than non-pregnant persons; however, recent studies have shown that COVID-19 during pregnancy is associated with severe outcomes such as high rate of maternal morbidity and mortality, and neonatal complications [12–14]. There are also emerging evidence that the risk of having stillbirth may be higher among pregnant COVID-19 patients [15]. These pre-neonatal and neonatal period complications are attributed to pregnant women's reduced respiratory capacity, low immunity, and the hemodynamic changes they undergo. The risk of severe maternal outcomes is even higher if they have pulmonary comorbidities, hypertensive disorders, and diabetes mellitus [16]. Moreover, investigations have shown women to be a vulnerable group during the COVID-19 pandemic. This worry is even more among pregnant women who occasionally experience pregnancy and postpartum mental illnesses (depression, anxiety, and postpartum psychosis), resulting in bipolar disorder [17]. These situations are a cause for concern in Somalia, whose women of reproductive age represent 38% of the household, with a worrying maternal mortality

rate of 692 [18]. Also, among the 23,102 cases as of 2/12/2021, 26% (amounting >6006 cases) are female.

The main strategy for each country is to vaccine their general public against COVID-19; the WHO and all governments around the globe are doing their best efforts and advocacy for mass vaccination. To date, a total of 7,772,799,316 vaccine doses have been done according to the data released daily by the WHO. The Ministry of health (MoH) of the federal government of Somalia has been vaccinating the public since 2020 based on vaccines donated by international organizations and some governments. Since the vaccination program started, the MoH was hesitant to vaccinate pregnant women for lack of evidence; however, on 18 November 2021, they released a newsletter stating that MoH recommends vaccinating pregnant women with a single dose J&J COVID-19 vaccine after the first trimester.

This survey was conducted among pregnant women to study if they were exposed to COVID-19 based on the *OnSite* COVID-19 IgG/IgM Rapid Test that detects anti-SARS-CoV-2 IgG and IgM antibodies in serum and plasma. The aim was to estimate the prevalence of diagnosed COVID-19 among pregnant women in Somalia's Benadir region. Also, a questionnaire was administered to consenting participants to determine demographic characteristics and potential risk factors for COVID-19. We also intend to evaluate the presence or otherwise of any association between the participant's sociodemographic features with their respective COVID-19 status.

MATERIAL AND METHODS

Study Design: We present a cross-sectional study aiming to estimate the Seroprevalence of SARS-CoV-2 antibodies among pregnant women attending referral hospitals in Mogadishu, Somalia, from July 31st 2021 to August 31st 2021 (**Figure 1**). Women who indicated their informed consent and had no history of COVID-19 vaccination were included in the survey. Participants who did not consent to participate in the study were excluded.

Study Setting: The selected hospitals are the major two referral hospitals for mother and child in the capital city of Mogadishu. Both hospitals are located on either side of the city and routinely offer free medical services to the mother and child. One hospital in the south provides services to

the most vulnerable in the society, mainly the internally displaced people (IDP) from the regions in the south of Somalia. And the other hospital located in the north of the city covers the city's north districts, including patients from nearby central Somalia regions. The consenting participants were administered a questionnaire covering demographics, obstetrical history, general health status, COVID-19 status, and COVID-19 preventive measures. The questionnaire was prepared using Google form for ease of use, processing, and analyzing the data generated.

Sample size determination

We assumed a 50% prevalence since no study had previously been done to determine the Seroprevalence of COVID-19 antibodies among pregnant women in Somalia.

Therefore, based on the Cochran's formula for sample size calculation ($N = Z^2 \times P\ (1\text{-}P) \div \varepsilon^2$)

Where, Z is 1.96 (constant), e is the desired level of precision (i.e. 5% margin of error at 95% confidence interval), p estimated prevalence (5.7%), and q is 1 – p.

Therefore

$N = Z^2 \times P\ (1\text{-}P) \div \varepsilon^2$

$N = 3.8416 \times 0.5\ (1\text{-}0.5) \div 0.0025$

$N = 384.16$ samples

However, in order to increase our chances of detection, 477 samples were collected.

Serological Testing: Participants were tested with the CTK BIOTECH's *OnSite* COVID-19 IgG/IgM Rapid Test (California, USA) following the instructions given by the manufacturer. The *OnSite* COVID-19 IgG/IgM Rapid Test is suitable for detecting individuals with recent or latent infection to SARS-CoV-2 virus infection, indicating recent or prior infection. The *OnSite* COVID-19 IgG/IgM Rapid Test is one of the most effective test for detecting previous exposure to SARS-CoV-2 virus infection virus with a 97.1% sensitivity and 97.8% specificity.
Four trained doctors, assisted by three junior doctors, and a final year obstetrician-gynecology postgraduate student participated in the blood sample collection and filling of the Google form questionnaires according to inputs from the participants (pregnant women attending antenatal services). Participants were given a detailed explanation of the study purpose and procedure, while the confidentiality of their data was granted.

The study's primary outcome was the seroprevalence of IgG & IgM-specific antibodies in a cohort of pregnant women during the study period. In our analysis, we stratified the population according

to the results of the serological study (IgG, IgM, & IgG/IgM positive vs. negative group). Those with positive IgG/IgM were further subdivided depending on the presence or absence of COVID-19 related risky behaviors, obstetrical characteristics, history of chronic illnesses, and COVID-19 symptoms at any time before the serological study using descriptive and inferential analysis.

Statistical Analysis: For the descriptive analysis, the general distribution of all the variables included in this study was assessed by frequency and percentages for categorical variables and means and standard deviations for continuous data using SPSS statistical software version 25. For inferential analysis, we used logistic regression to examine the relationship between predictor variables and the outcome variables.

Patient and Public Involvement: It was not appropriate or possible to involve patients or the public in the design, or conduct, or reporting, or dissemination plans of our research.

Research Ethics Approval: The investigation commenced after Our Institutional Review Board approved all study procedures (SIMAD University Ethics Committee. **ID:** IMRSU/FMHS (FR18) P003).

RESULTS

From July 31st 2021 to August 31st 2021, a total of 477 eligible pregnant women were tested for SARS-COV-2 virus infection specific antibodies. The single-use lateral flow immunoassay test kit is used for detection and differentiation of anti-SARS-CoV-2 virus infection IgG and IgM immunoglobulins where a total of 302 (63.3%) serum samples were found to be negative for SARS-CoV-2 virus infection while 175 (36.7%) turned out to be positive (**Figure 2a**). Similarly, 34% of the circulating antibodies were IgG indicating long-term infection, while IgM circulation was found in only 2% of the women (**Figure 2b**).

The COVID-19-related sociodemographic characteristics analyzed, including age, occupational status, and the number of people in the household, were all found not to be statistically significant (p>0.05). However, other demographics studied like marital status, showed that respondents that are married have increased risk of contracting the COVID-19 infection in relation to their counterparts that are not married, and this finding is statistically significant (**Table 1**). Similarly, in terms of the education status, not having formal education was found to be a statistically significant risk factor for contracting COVID-19 with p-value of 0.004. Important to note that, statistical significance in this case does not equate causation, rather, it implies increased risk.

Table 1: Socio-demographic characteristics of pregnant women in Mogadishu, Somalia

Demographics	N	COVID-19 (IgG/IgM)		OR at 95%CI	P value
		Positive (175)	Negative (302)		
Age					
<25 years	213(44.7)	72 (41.1)	141 (46.7)	1.253(0.860-1.826)	0.241
≥25 years	264(55.3)	103 (58.9)	161 (53.3)	Ref.cat	
Marital status					
Married	341 (71.5)	109 (62.3)	232 (76.8)	2.007(1.337-3.012)	0.001*
Unmarried	136 (28.2)	66 (37.7)	70 (23.2)	Ref.cat	
Educational level					
Informal education	267(56.0)	83 (47.4)	184 (60.9)	1.728(1.187-2.518)	0.004*
Formal Education	210(44.0)	92 (52.6)	118 (39.1)	Ref.cat	
Occupation					
Unemployed	359 (75.3)	119 (68.0)	240 (79.5)	1.822(1.193-2.781)	0.005*
Employed	118 (24.7)	56 (32.0)	62 (20.5)	Ref.cat	
No. of household					
≤5	103 (21.6)	32 (18.3)	71 (23.5)	Ref.cat	
>5	374 (78.4)	143 (81.7)	231 (76.5)	0.728(0.457-1.161)	0.182

* Statistically significant at the 0.05 level

According to the obstetrical characteristics of the respondents, 34 (19.4%) of women who reported they had given birth to less than two children were found to have circulating levels of SARS-CoV-2 antibodies, and this result was statistically significant at p=0.0001. While the other variables (history of abortion and stage of gestation) were not a potential risk factor to acquiring COVID-19 since none of them was found to be significant (**Table 2**).

Table 2: Obstetric characteristics of pregnant women in Mogadishu, Somalia

Characteristic	N	COVID-19 IgG/IgM test		OR 95%CI	P value
		Positive (175)	Negative (302)		
Parity					
0-2	141 (29.6)	34 (19.4)	107 (35.4)	0.439(0.289-0.684)	0.0001*
>2	336 (70.4)	141 (80.6)	195 (64.6)	Ref.cat	
History of abortion					
Yes	105 (22.0)	35 (20.0)	70 (23.2)	0.829(0.525-1.308)	0.420
No	372 (78.0)	56 (22.0)	50 (16.6)	Ref.cat	
Gestational age					
<13 weeks	65 (13.6)	29 (16.6)	36 (11.9)	Ref.cat	0.127
14-26 weeks	92(19.3)	30(17.1)	62 (20.5)	1.665(0.865-3.205)	0.206

* Statistically significant at the 0.05 level

Some of the unhealthy behaviors reported to increase the risk of other respiratory illnesses were also evaluated in this study. Notable among them is the smoking of cigarettes, Shisha, and the local habit of chewing Khat (*Catha edulis*), a stimulant plant frequently chewed among Somalis. Among these, only the smoking of shisha (4.6% positive) was found to pose a risk for contracting COVID-19 infection due to sharing of pipes.

Furthermore, human-to-human transmission of COVID-19 is precipitated by close contact with family members and is usually high when the number of families in a household is considerable. In order to evaluate the association between the number of people in the household with the risk of contracting the infection, participants were asked questions relating to knowledge about their COVID-19 status, familiarity with the basic clinical signs of COVID-19, the possibility of transmission within family members as well as observance of public health preventive measures (**Table 3**).

Table 3: COVID-19 status among pregnant women in Mogadishu, Somalia

Characteristic	N	COVID-19 (IgG/IgM)		OR 95%(CI)	P value
		Positive (175)	Negative (302)		
Were you ever tested for COVID-19?					
Yes	139 (29.1)	67 (38.3)	72 (23.8)	1.982(1.324-2.967)	0.001*
No	338 (70.9)	108 (61.7)	230 (76.2)	Ref.cat	

What was the result?					
Positive	55 (11.6)	34 (19.5)	21 (7.0)	0.283(0.156-0.511)	0.0001*
Negative	96 (20.2)	38 (21.8)	58 (19.2)	0.698(0.436-1.119)	0.135
Not applicable	325 (68.3)	102 (58.6)	223 (73.8)	Ref.cat	
Have you ever had COVID-19?					
Yes	102 (21.4)	60 (34.3)	42 (13.9)	0.639(0.385-1.060)	0.083
No	222 (46.5)	42 (24.0)	180 (59.6)	3.911(2.464-6.207)	0.0001*
Not sure	153 (32.1)	73 (41.7)	80 (26.5)	Ref.cat	
Did you have COVID-19 symptoms?					
Yes	193 (40.5)	126 (72.0)	67 (22.2)	9.019(5.883-13.827)	0.0001*
No	284 (59.5)	49 (28.0)	235 (77.8)	Ref.cat	
Did you have fever?					
Yes	212 (44.4)	130 (74.3)	82 (27.2)	7.751(5.076-11.836)	0.0001*
No	265 (55.6)	45 (25.7)	220 (72.8)	Ref.cat	
Did you have cough?					
Yes	216 (45.3)	138 (78.9)	78 (25.8)	10.711(6.864-16.715)	0.0001*
No	261(54.7)	37 (21.1)	224 (74.2)	Ref.cat	
Did you lose your smell?					
Yes	180 (37.7)	127 (72.6)	53 (17.5)	12.430(7.964-19.401)	0.0001*
No	297 (62.3)	48 (27.4)	249 (82.5)	Ref.cat	
Did you lose your taste?					
Yes	166 (34.8)	118 (67.4)	48 (15.9)	10.955(7.043-17.038)	0.0001*
No	311 (65.2)	57 (32.6)	254 (84.1)	Ref.cat	
Did you have stomach upset?					
Yes	135 (28.3)	103 (58.9)	32 (10.6)	12.070(7.512-19.395)	0.0001*
No	342 (71.7)	72 (41.1)	270 (89.4)	Ref.cat	
Did you have shortness of breath?					
Yes	170 (35.6)	122 (69.7)	48 (15.9)	12.181(7.796-19.031)	0.0001*
No	307 (64.4)	53 (30.3)	254 (84.1)	Ref.cat	
When was the time you had the symptoms					
<3 months	87 (18.2)	48 (27.4)	39 (12.9)	0.075(0.039-0.0146)	0.0001*
3-6 months	35 (7.3)	22 (12.6)	13 (4.3)	0.055(0.023-0.129)	0.0001*
>6 months	166 (34.8)	89 (50.9)	77 (25.5)	0.080(0.044-0.145)	0.0001*
Not applicable	189 (39.6)	16 (9.1)	173 (57.3)	Ref.cat	
Close contact with someone having COVID-19					
Yes	158 (33.1)	110 (62.9)	48 (15.9)	0.218(0.117-0.407)	0.0001*
No	256 (53.7)	44 (25.1)	212 (70.2)	2.409(1.201-4.462)	0.005*
Not sure	63 (13.2)	21 (12.0)	42 (13.9)	Ref.cat	
Did any household contact colleagues or close friend had COVID-19?					
Yes	195 (40.9)	126 (72.0)	69 (22.8)	8.683(5.674-13.288)	0.0001*
No	282 (59.1)	49 (28.0)	233 (77.2)	Ref.cat	
Was anyone of your close contacts hospitalized for COVID-19					
Yes	169 (35.4)	115 (65.7)	54 (17.9)	8.802(5.732-13.518)	0.0001*
No	308 (64.6)	60 (34.3)	248 (82.1)	Ref.cat	
Did anyone of your close contacts die of COVID-19?					
Yes	182 (38.2)	124 (70.9)	58 (19.2)	10.229(6.628-15.785)	0.0001*
No	295 (61.8)	51 (29.1)	244 (80.8)	Ref.cat	

* Statistically significant at the 0.05 level

A total of 193 pregnant women reported having had COVID-19 infection, out of which 126 (72%) presented clinical signs indicative of the disease while asymptomatic were 67(22.2%). The most common symptom presented by the infected women were cough (78.9%), fever (74.3%), shortness

of breath (69.7%), loss of smell (72.6%), and stomach upset (58.9%). The timing of symptoms appearing differed significantly between gestations, first trimester (27.4%), second trimester (12.6%), and third trimester (50.9%). Close contact with a family member of someone who had COVID-19 was also a significant finding for testing positive with a p-value =0.004. We also observed that the number of close contacts the respondents knew who had A total of 193 pregnant women reported having had COVID-19 infection out of which 126 (72%) presented clinical signs indicative of the disease while asymptomatic were 67(22.2%). The most common symptom presented by the infected women were cough (78.9%), fever (74.3%), shortness of breath (69.7%), loss of smell (72.6%), and stomach upset (58.9%). The timing of symptoms appearing differed significantly between gestations, first trimester (27.4%), second trimester (12.6%), and third trimester (50.9%). Close contact with a family member of someone who had COVID-19 was also a significant finding for testing positive with a p-value =0.004. We also observed that the number of close contacts the respondents knew whom COVID-19 had was more likely hospitalized (65.7%) or died of the infection (70.9%).

Observing social and physical distances was statistically significant compared with not observing this essential preventive measure (**Table 4**). The result revealed that 41.7% of the respondents admitted to observing distancing among others (168), which is lower than the number of respondents that admitted to not practicing distancing (308), and this was found to be statistically significant ($p<0.05$). Except for the use of face mask, which showed the number of those using it (268) was higher than those not using (209), the adherence to other preventive measures was poor, particularly frequent hand washing, which showed 53.1% not practicing handwashing compared to 46.9% that claimed they regularly wash their hands. Importantly, this finding was not statistically significant; however, the odds are greater than 1, implying that not adhering to these preventive measures could increase the chances of contracting COVID-19.

Table 4: Preventive measures observed by the of pregnant women in Mogadishu, Somalia

Characteristic	N	COVID-19 (IgG/IgM)		OR 95%CI	P value
		Positive (175)	Negative (302)		

Do you regularly wear face mask?					
Yes	268 (56.2)	108 (61.7)	160 (53.0)	Ref.cat	
No	209 (43.8)	67 (38.3)	142 (47.0)	1.431(0.979-2.091)	0.064
If "yes", what types of mask do you wear?					
N95	43 (9.0)	18 (10.3)	25 (8.3)	Ref.cat	
Surgical face mask	79 (16.6)	23 (13.1)	56 (18.5)	1.753(0.807-3.810)	0.156
Others	163 (34.2)	70 (40.0)	93 (30.8)	0.957(0.484-1.889)	0.898
Not applicable	192 (40.3)	64 (36.6)	128 (42.4)	1.440(0.732-2.831)	0.290
Do you regularly wash your hands					
Yes	205 (43.0)	82 (46.9)	123 (40.7)	Ref.cat	
No	272 (57.0)	93 (53.1)	179 (59.3)	1.283(0.882-1.868)	0.193
Do you keep your distance from others					
Yes	168 (35.2)	73 (41.7)	95 (31.5)	Ref.cat	
No	309 (64.8)	102 (58.3)	207 (68.5)	1.643(0.903-2.988)	0.104
Do you avoid handshaking?					
Yes	164 (34.4)	66 (37.7)	98 (32.5)	Ref.cat	
No	313 (65.6)	109 (62.3)	204 (67.5)	0.858 (0.484-1.520)	0.599

* Statistically significant at the 0.05 level

Comorbidities of pregnant women with confirmed SARS-CoV-2 virus infection are shown in **Table 5**. There was a significant difference in mean between the COVID-19-positive pregnant women and COVID-19 negative pregnant women across all the comorbidities inquired (diabetes, hypertension, cardiovascular disease, and asthma) with a p-value of 0.001. The odds ratio was also greater than 1, which means greater odds of association with having any chronic illness and the chances of becoming infected with COVID-19.

Table 5: Comorbidities of pregnant women with conformed SARS-CoV-2 virus infection

Characteristic	**N**	**COVID-19 (IgG/IgM)**		**OR 95%CI**	**P value**
		Positive (175)	**Negative (302)**		

Do you have diabetes?					
Yes	94(19.7)	50 (28.6)	44 (14.6)	2.345(1.484-3.708)	0.0001*
No	383 (80.3)	125(71.4)	258 (85.4)	Ref.cat	
Do you have hypertension?					
Yes	124 (26.0)	67 (38.3)	57(18.9)	2.667(1.753-4.056)	0.0001*
No	353 (74.0)	108 (61.7)	245 (81.1)	Ref.cat	
Do you have cardiac disease?					
Yes	85 (17.8)	46 (26.3)	39 (12.9)	2.811(1.721-4.590)	0.0001*
No	392 (82.2)	129 (73.7)	263 (87.1)	Ref.cat	
Do you have asthma?					
Yes	85 (17.8)	46 (26.3)	39 (12.9)	2.405(1.494-3.870)	0.0001*
No	392 (82.2)	129 (73.7)	263 (87.1)	Ref.cat	
Do you have family history of hypertension?					
Yes	137 (28.7)	63 (36.0)	74 (24.5)	1.733(1.156-2.598)	0.008*
No	340 (71.3)	112 (64.0)	228 (75.5)	Ref.cat	
Do you have family history of diabetes?					
Yes	148 (31.0)	72 (41.1)	76 (25.2)	2.079(1.397-3.094)	0.0001*
No	329 (69.0)	103 (58.9)	226 (74.8)	Ref.cat	
Do you have family history of cardiac disease?					
Yes	155 (32.5)	76 (43.4)	79 (26.2)	2.167(1.461-3.213)	0.0001*
No	322 (67.5)	99 (56.6)	223 (73.8)	Ref.cat	
Do you have family history of asthma?					
Yes	137 (28.7)	64 (36.6)	73 (24.2)	1.809(1.206-2.712)	0.004*
No	340 (71.3)	111 (63.4)	229 (75.8)	Ref.cat	
Do you have family history of obesity?					
Yes	193 (40.5)	89 (50.9)	104 (34.4)	1.970(1.348-2.880)	0.0001*
No	284 (59.5)	86 (49.1)	198 (65.6)	Ref.cat	
Do you take regular medications?					
Yes	137 (28.7)	66 (37.7)	71 (23.5)	0.494(0.328-0.744)	0.001*
Herbal medication	19 (4.0)	8 (4.6)	11 (3.6)	0.631(0.246-1.617)	0.338
No	321 (67.3)	101 (57.7)	220 (72.8)	Ref.cat	

* Statistically significant at <0.05

DISCUSSION

The cross-sectional approach used was because of the urgent need to understand the status of the disease among pregnant women due to their suppressed immune status, especially given the speed

at which the disease was developing. This study investigated the prevalence, knowledge, and preventive practices towards COVID-19 among pregnant women seeking antenatal services in two of the major public hospitals in Mogadishu, within the Benadir region of Somalia. The study coincided with the third wave of the COVID-19 outbreak in Somalia around early July 2021. During this period, a total of 477 pregnant women were screened for confirmation of COVID-19 using the CTK BIOTECH's *OnSite* COVID-19 IgG/IgM Rapid Test kit which is capable of identifying SARS-CoV-2 antibodies with 97.1% and 97.8% sensitivity and specificity respectively [19]. To date, the most reliable method of detecting SARS-CoV-2 virus infection is RT-PCR [20,21]. Nonetheless, the *OnSite* COVID-19 IgG/IgM Rapid Test can identify individuals with circulating antibodies against the SARS-CoV-2 virus infection either as a result of recent or prior infection [19]. In this study, the predominant immunoglobulin among the COVID-19 positive pregnant women was IgG with 34% circulation followed by IgM with 2%. During the acute phase of COVID-19 infection, IgM blood levels against SARS-CoV-2 virus infection rise rapidly and peak after 2-3 weeks of contracting the virus, followed by SARS-CoV-2 virus infection specific IgG antibodies appearing and persist in the circulation for months. Because of the inability of the test kit (*OnSite* COVID-19 IgG/IgM) to distinguish COVID-19 vaccine-induced antibodies and antibodies as a result of SARS-CoV-2 infection, we decide to exclude all pregnant women that have received single or multiple shots of the COVID-19 vaccine. This ensures that only pregnant women with infection (acute or chronic) are diagnosed as positive [22]. Based on this, the majority of the COVID-19 positive pregnant women sampled were found to have a chronic long-term infection (predominance of IgG). This outcome is similar to the previous report where titers of IgG targeting N-protein of SARS-CoV2 was recommended as a prognostic factor in understanding the clinical course of COVID-19 and that it should be measured in all patients with SARS-CoV2 infection [23].

The overall prevalence of SARS-CoV-2 virus infection among pregnant women was 36.7%, with 3% of the total having an active infection, but none needed critical care. Even though earlier studies have reported a prevalence of 61% among healthcare workers, the 36.7% recorded in this study is distressing, this is because the 61% we referred to was from a study conducted among healthcare workers in Somalia [24]. It is not a surprise to see a high number of cases among this category of people because they constitute the frontline workers at the most significant risk of contracting the

disease [25]. This figure (36.7%) is considerably high when studies were done in Japan and New York, which found a seroprevalence of 0.03% and 16.4%, respectively [16,26].

Concerning the adherence to the outlined preventive measures, including avoiding crowd, frequent washing of hands with detergents or disinfectants, and the use of face coverings, we observed a worrying trend where the majority of the respondents admitted to not practicing these aforementioned public health guidelines with an increased odd of contracting the disease as a result (OR>1). This undesirable habit of not adhering to the recommended preventive practice may give further credence to the high number of positive cases recorded in this study. We understand that observing these set-out regulations will be challenging and complex because of some Somali culture and traditions of congregating, sharing hugs, and shaking hands. Nonetheless, considering the vulnerabilities of pregnant women, there is an urgent need to ensure compliance with these COVID-19 requirements; otherwise, things may only worsen for pregnant women in Somalia. It is important to point out that, based on the results of this study, no difference in terms of increased risk was observed between wearing mask and not wearing. This may not however be surprising because public mask wearing is most effective at reducing spread of the virus when the recommended mask is worn properly with high compliance [27]. Additionally, because wearing masks has been reported to bring down the overall risk of spreading COVID-19, people have become careless and less likely to abide by standard measures and more willing to take other risks, such as decreasing the physical distance between them and others. Furthermore, despite the results showing no risk of contracting infection regardless of whether a mask is worn or not, in contrast to the popular report on face covering, it is likely that this discrepancy may be because of the careless attitude among people wearing mask for the mere believe that the mask will protect them. Interestingly, only 25.6% of those that claimed they wear mask reported they used the recommended mask (N95-9% and surgical mask 16.6%). The remaining reported wearing masks made of simple clothes while others considered Islamic face veil (Niqab) to be enough face mask for COVID-19 prevention.

Additional vital findings in this study are the relationship of COVID-19 positive status and comorbidity. Since the first outbreak, we have come to realize that SARS-CoV-2 infects people of all age groups; however, elderly people (above 60 years), as well as individuals with comorbidities

such as chronic respiratory disease (asthma patients), diabetes and cardiovascular diseases, are at a greater risk of developing infection with severe outcomes [28,29]. Although most of the respondents admitted to not having any of the chronic disease conditions asked, viz hypertension, diabetes, asthma, cardiovascular disease, and obesity (74-82%). Nevertheless, many pregnant women (17.8-28.7%) indicated they have one or more of these comorbidities, as mentioned earlier, which will increase the risk for them and their unborn children.

Other potential risk factors evaluated in this study, such as parity, history of abortion, stage of gestation, and some unhealthy behaviors like smoking, revealed no significant relationship concerning increasing chances of contracting COVID-19 among pregnant women, with an odds ratio of 0.4 to 0.8. However, the risk for contracting the disease for smokers of Shisha was very high with an odds ratio of 3.569, and this finding was statistically significant (p=0.04). Like other studies, none of the different trimesters of pregnancy was associated with a high risk of getting the infection. A study done in Spain found that Seroprevalence was similar between women in the first trimester of pregnancy and women in the third trimester, suggesting a similar risk of infection. However, the proportion of women with symptoms and those requiring hospitalization was higher in the third-trimester group than in the first-trimester group [30,31]. On the other hand, available data have already indicated that smoking doubles the risk of having severe COVID-19 [32]. Lung damage from COVID-19 resembles the damage of smoke from cigarettes and other tobacco products that introduce particulate matter from the environment into the lungs. Notably, the mouthpiece and the hose in the shisha can serve as a means of transmission of the COVID-19 virus, which can also spread through shisha sharing.

Participants who reported COVID-like symptoms were more likely to turn positive when tested for COVID-19. Though some reported no history of COVID-19 infection, this wave arrived simultaneously with the already expected seasonal flue. The order and frequency of symptoms were almost the same with a study done in Mogadishu in which the most typical symptom reported was cough (>75%), followed by fever (>71%) and loss of taste and smell [33]. Other studies show that fever and cough were the most typical symptoms reported, followed by stomach upset [34]. We also observed that pregnant women who reported having had a previous infection with COVID-19 were more likely to test positive. Though COVID-19 specific immunity may disappear

in three months, one may believe that since they were infected in previous waves, they still sustain immunity and do not practice preventive measures [35].

Despite the findings reported in this study, it is important to emphasize that the method of data collection and assay utilized are fraught with some limitations as earlier mentioned. One of such limitation is the tendency for the respondents to give a less accurate answer when asked retrospective questions. In order for us to evaluate their current situation with respect to COVID-19 related practices and behaviors, we needed baseline information prior to COVID-19 outbreak. Studies have shown that measurement error can arise when high cognitive questions retrospective inquiries are made as well as the inability of the respondents to remember specific details about their pre-COVID-19 routine hygiene and sanitation practices [36]. Also the inability of the rapid test kit to distinguish between cross-reacting antibodies like Secretory Immunoglobulin A (SIgA) produced against other Corona viruses by the mucosal immunity may result in false positive detection [37].

In conclusion, the COVID-19 high prevalence observed in this study is disturbing considering how vulnerable pregnant women can be, especially in Somalia, where the healthcare services face serious challenges. The poor attitude in observing preventive measures against COVID-19 among pregnant women also warrants serious attention towards raising awareness among midwives and health care workers who are in close contact with women delivering babies to reduce infection transmission and ensure prevention and control of the virus.

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References

1. Somalia: WHO Coronavirus Disease (COVID-19) Dashboard With Vaccination Data | WHO Coronavirus (COVID-19) Dashboard With Vaccination Data [Internet]. [cited 2021 May 25]. Available from: https://covid19.who.int/region/emro/country/so
2. Partnership for Evidence-Based Response to COVID-19 (PERC) - Prevent Epidemics [Internet]. [cited 2021 Nov 13]. Available from: https://preventepidemics.org/covid19/perc/
3. Chitungo I, Dzobo M, Hlongwa M, Dzinamarira T. COVID-19: Unpacking the low number of cases in Africa. Public Heal Pract [Internet]. 2020 Nov [cited 2021 Nov 13];1:100038. Available from: /pmc/articles/PMC7485446/
4. Osei SA, Biney RP, Anning AS, Nortey LN, Ghartey-Kwansah G. Low incidence of COVID-19 case severity and mortality in Africa; Could malaria co-infection provide the missing link? BMC Infect Dis [Internet]. 2022 Dec 1 [cited 2022 Mar 14];22(1):1–11. Available from: https://bmcinfectdis.biomedcentral.com/articles/10.1186/s12879-022-07064-4
5. Lawal Y. Africa's low COVID-19 mortality rate: A paradox? Int J Infect Dis. 2021 Jan 1;102:118–22.
6. Nkengasong J. Let Africa into the market for COVID-19 diagnostics. Nature. 2020 Apr 30;580(7805):565–565.
7. COVID-19 in Somalia: A Public Health Emergency in an Electoral Minefield | Crisis

Group [Internet]. [cited 2021 Nov 13]. Available from: https://www.crisisgroup.org/africa/horn-africa/somalia/b155-covid-19-somalia-public-health-emergency-electoral-minefield

8. Sanyaolu A, Okorie C, Marinkovic A, Patidar R, Younis K, Desai P, et al. Comorbidity and its Impact on Patients with COVID-19. Sn Compr Clin Med [Internet]. 2020 Aug [cited 2021 Nov 13];2(8):1. Available from: /pmc/articles/PMC7314621/

9. Garba B, Zakaria Z, Salihu MD, Bande F, Saidu B, Bala JA. Breaking the cycle of the COVID-19 transmission: A challenge for Nigeria. J Glob Health. 2020;10(2).

10. Adam MH, Mohamoud JH, Mohamood AS, Mohamed AA, Garba B, Dirie NI. Seroprevalence of Anti-SARS-CoV-2 Antibodies in Benadir Region, Somalia. Vaccines [Internet]. 2022 Jan 30 [cited 2022 Mar 1];10(2):220. Available from: /pmc/articles/PMC8877673/

11. Wang CL, Liu YY, Wu CH, Wang CY, Wang CH, Long CY. Impact of COVID-19 on Pregnancy. Int J Med Sci [Internet]. 2021 [cited 2022 Mar 14];18(3):763. Available from: /pmc/articles/PMC7797535/

12. Ames JL, Ferrara A, Avalos LA, Badon SE, Greenberg MB, Hedderson MM, et al. COVID-19 prevalence, symptoms, and sociodemographic disparities in infection among insured pregnant women in Northern California. PLoS One [Internet]. 2021 Sep 1 [cited 2021 Nov 13];16(9):e0256891. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0256891

13. Villar J, Ariff S, Gunier RB, Thiruvengadam R, Rauch S, Kholin A, et al. Maternal and Neonatal Morbidity and Mortality Among Pregnant Women With and Without COVID-19 Infection: The INTERCOVID Multinational Cohort Study. JAMA Pediatr [Internet]. 2021 Aug 1 [cited 2022 Mar 14];175(8):817–26. Available from: https://jamanetwork.com/journals/jamapediatrics/fullarticle/2779182

14. Iacobucci G. Covid-19: Severe infection in pregnancy significantly increases risks, study shows. BMJ [Internet]. 2022 Feb 24 [cited 2022 Mar 14];376:o480. Available from: https://www.bmj.com/content/376/bmj.o480

15. Khalil A, Von Dadelszen P, Draycott T, Ugwumadu A, O'Brien P, Magee L. Change in the Incidence of Stillbirth and Preterm Delivery During the COVID-19 Pandemic. JAMA [Internet]. 2020 Aug 18 [cited 2021 Nov 13];324(7):705. Available from: /pmc/articles/PMC7435343/

16. NM M, A R, Ld W, SM D, W L, E I, et al. Seroprevalence of SARS-CoV-2 during pregnancy and associated outcomes: results from an ongoing prospective cohort study, New York City. 2021 Feb 3 [cited 2021 Nov 13]; Available from: https://europepmc.org/article/PPR/PPR277509

17. Esteban-Gonzalo S, Caballero-Galilea M, González-Pascual JL, Álvaro-Navidad M, Esteban-Gonzalo L. Anxiety and Worries among Pregnant Women during the COVID-19 Pandemic: A Multilevel Analysis. Int J Environ Res Public Health [Internet]. 2021 Jul 1 [cited 2021 Nov 13];18(13). Available from: /pmc/articles/PMC8297358/

18. Ahmed MAM, Fodjo JNS, Gele AA, Farah AA, Osman S, Guled IA, et al. COVID-19 in Somalia: Adherence to Preventive Measures and Evolution of the Disease Burden. Pathog 2020, Vol 9, Page 735 [Internet]. 2020 Sep 6 [cited 2021 Nov 13];9(9):735. Available from: https://www.mdpi.com/2076-0817/9/9/735/htm

19. Lagerqvist N, Maleki KT, Verner-Carlsson J, Olausson M, Dillner J, Wigren Byström J, et al. Evaluation of 11 SARS-CoV-2 antibody tests by using samples from patients with defined IgG antibody titers. Sci Reports 2021 111 [Internet]. 2021 Apr 7 [cited 2021 Nov 14];11(1):1–8. Available from: https://www.nature.com/articles/s41598-021-87289-6

20. Kevadiya BD, Machhi J, Herskovitz J, Oleynikov MD, Blomberg WR, Bajwa N, et al. Diagnostics for SARS-CoV-2 infections. Nat Mater 2021 205 [Internet]. 2021 Feb 15 [cited 2021 Nov 14];20(5):593–605. Available from: https://www.nature.com/articles/s41563-020-00906-z

21. Liu R, Han H, Liu F, Lv Z, Wu K, Liu Y, et al. Positive rate of RT-PCR detection of SARS-CoV-2 infection in 4880 cases from one hospital in Wuhan, China, from Jan to Feb 2020. Clin Chim Acta. 2020 Jun 1;505:172–5.

22. Mouliou DS, Gourgoulianis KI. False-positive and false-negative COVID-19 cases: respiratory prevention and management strategies, vaccination, and further perspectives. Expert Rev Respir Med [Internet]. 2021 [cited 2022 Apr 30];15(8):1. Available from: /pmc/articles/PMC8074645/

23. Batra M, Tian R, Zhang C, Clarence E, Sacher CS, Miranda JN, et al. Role of IgG against N-protein of SARS-CoV2 in COVID19 clinical outcomes. Sci Reports 2021 111 [Internet]. 2021 Feb 10 [cited 2021 Nov 14];11(1):1–9. Available from: https://www.nature.com/articles/s41598-021-83108-0

24. Abdi A, Ahmed AY, Abdulmunim M, Karanja MJ, Solomon A, Muhammad F, et al. Preliminary findings of COVID-19 infection in health workers in Somalia: A reason for concern. Int J Infect Dis [Internet]. 2021 Mar 1 [cited 2021 Nov 14];104:734. Available from: /pmc/articles/PMC7872860/

25. Atnafie SA, Anteneh DA, Yimenu DK, Kifle ZD. Assessment of exposure risks to COVID-19 among frontline health care workers in Amhara Region, Ethiopia: A cross-sectional survey. PLoS One [Internet]. 2021 Apr 1 [cited 2021 Nov 14];16(4):e0251000. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0251000

26. Arakaki T, Hasegawa J, Sekizawa A, Ikeda T, Ishiwata I, Kinoshita K, et al. Clinical characteristics of pregnant women with COVID-19 in Japan: a nationwide questionnaire survey. BMC Pregnancy Childbirth [Internet]. 2021 Dec 1 [cited 2021 Nov 14];21(1):1–8. Available from: https://bmcpregnancychildbirth.biomedcentral.com/articles/10.1186/s12884-021-04113-9

27. Kai D, Goldstein G-P, Morgunov A, Nangalia V, Rotkirch A. Universal Masking is Urgent in the COVID-19 Pandemic: SEIR and Agent Based Models, Empirical Validation, Policy Recommendations. 2020 Apr 22 [cited 2022 Mar 14]; Available from: http://arxiv.org/abs/2004.13553

28. Ejaz H, Alsrhani A, Zafar A, Javed H, Junaid K, Abdalla AE, et al. COVID-19 and comorbidities: Deleterious impact on infected patients. J Infect Public Health [Internet]. 2020 Dec 1 [cited 2021 Nov 14];13(12):1833. Available from: /pmc/articles/PMC7402107/

29. WHO. Coronavirus disease (COVID-19): situation report, 141 [Internet]. 2020. [cited 2021 Nov 14]. Available from: https://apps.who.int/iris/handle/10665/332390

30. Crovetto F, Crispi F, Llurba E, Figueras F, Dolores Gómez-Roig M, Gratacós E, et al. SEROPREVALENCE AND CLINICAL SPECTRUM OF SARS-CoV-2 INFECTION IN THE FIRST VERSUS THIRD TRIMESTER OF PREGNANCY. medRxiv [Internet]. 2020 Jun 19 [cited 2021 Nov 14];2020.06.17.20134098. Available from: https://www.medrxiv.org/content/10.1101/2020.06.17.20134098v1

31. Lopez M, Hawkins-Villarreal A, Goncé A, Ribera L, Valdes-Bango Curell M, Castillo K, et al. OP03.02: Clinical spectrum of COVID-19 infection throughout gestation. Ultrasound Obstet Gynecol [Internet]. 2021 Oct [cited 2021 Nov 14];58(S1):65–65. Available from: https://onlinelibrary.wiley.com/doi/full/10.1002/uog.23939

32. Eastin C, Eastin T. Clinical Characteristics of Coronavirus Disease 2019 in China: Guan W, Ni Z, Hu Y, et al. N Engl J Med. 2020 Feb 28 [Online ahead of print] DOI: 10.1056/NEJMoa2002032. J Emerg Med [Internet]. 2020 Apr [cited 2021 Nov 14];58(4):711. Available from: /pmc/articles/PMC7266766/

33. Mohamud MFY, Mohamed YG, Ali AM, Adam BA. Loss of Taste and Smell are Common Clinical Characteristics of Patients with COVID-19 in Somalia: A Retrospective Double Centre Study. Infect Drug Resist [Internet]. 2020 [cited 2021 Nov 14];13:2631. Available from: /pmc/articles/PMC7406326/

34. Larsen JR, Martin MR, Martin JD, Kuhn P, Hicks JB. Modeling the Onset of Symptoms of COVID-19. Front Public Heal. 2020 Aug 13;8:473.

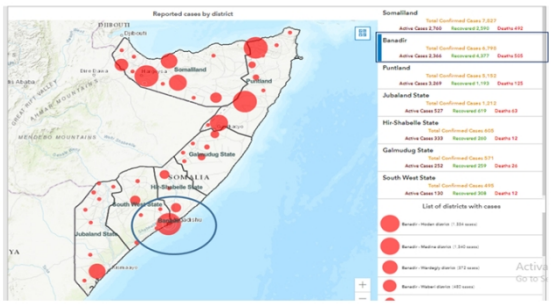
35. Arkhipova-Jenkins I, Helfand M, Armstrong C, Gean E, Anderson J, Paynter RA, et al. Antibody Response After SARS-CoV-2 Infection and Implications for Immunity: A Rapid Living Review. Ann Intern Med [Internet]. 2021 Jun 1 [cited 2021 Nov 14];174(6):811–21. Available from: /pmc/articles/PMC8025942/

36. Hipp L, Bünning M, Munnes S, Sauermann A. Problems and pitfalls of retrospective survey questions in COVID-19 studies. Surv Res Methods [Internet]. 2020 [cited 2022 May 13];14(2):109–1145. Available from: https://www.econstor.eu/handle/10419/222251

37. Tsukinoki K, Yamamoto T, Handa K, Iwamiya M, Saruta J, Ino S, et al. Detection of cross-reactive immunoglobulin A against the severe acute respiratory syndrome-coronavirus-2 spike 1 subunit in saliva. PLoS One [Internet]. 2021 Nov 1 [cited 2022 May 13];16(11):e0249979. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0249979

Figure 1: Map of Somalia showing the COVID-19 cases and death (13/11/2021) with the study area (Benadir region) having the second highest number of confirmed cases (6,798) and the highest mortality (505). https://covid19som-ochasom.hub.arcgis.com/

Figure 2: Overall prevalence of SARS-CoV-2 virus antibodies among pregnant women in Mogadishu, Somalia



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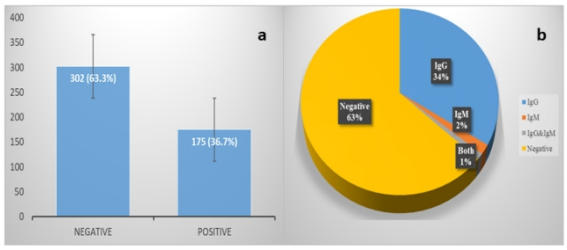

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	4
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	6-12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	-

		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.